When HRCT requires brain MRI: (intra)cranial manifestations in diffuse parenchymal lung diseases, a pictorial review

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Learning objectives

To highlight the spectrum of neuroradiological manifestations associated with diffuse parenchymal lung diseases (DPLDs).
Background

DPLDs comprise a complex group of more than 200 diseases including sarcoidosis, Langerhans cell hystiocytosis (LCH), lymphangioleiomyomatosis (LAM), and vasculitis. Some of them are associated with multisystemic manifestations, of which cerebral involvement results in significant morbidity and mortality. Intracranial lesions have been observed during the course of the disease in patients with known disease, but they also can precede the diagnosis of these disorders as the first presenting manifestation, in which case they can cause considerable diagnostic problems.
Findings and procedure details

Sarcoidosis:

· Definition:

Sarcoidosis is a multisystem disorder characterized by the development of noncaseating granulomas, frequently found in relation with lymphatics. Often called the "great mimicker", it can involve many organs with multiple clinical presentations, with most of them related to pulmonary, skin and ocular involvement [1]. It typically presents in young and middle-age adults under the age of 50 years, although children and elderly may also be affected. The diagnosis is established when clinic-radiological findings are supported by histological evidence of noncaseating epithelioid granulomas (Fig. 1, 2) [2].

· Thoracic involvement:

Sarcoidosis affects the thorax in at least 90% of cases [2], most frequently manifesting with intrathoracic symmetric lymphadenopathy and pulmonary parenchymal changes, which are a manifestation of interstitial or airway granulomas. The variety of abnormalities that may be seen on HRCT include nodules, consolidation and masses, ground glass and confluent alveolar opacities (alveolar sarcoid), interlobular septal thickening and fibrocystic changes [1]. Pulmonary fibrosis may develop in up to 25% of patients [1]. The abnormalities predominate in the upper and middle zones of the lungs. Typically, pulmonary sarcoidosis presents with well-defined micronodules with typical perilymphatic distribution along the bronchovascular bundles and subpleural interstitium adjacent to fissures (Fig. 1A-B, Fig. 8A-B). Frequently clusters of peribronchovascular nodules can converge in an area of mass-like consolidation with individual nodules at the periphery of the lesion forming the "galaxy sign", most commonly seen with sarcoidosis. The lymphadenopathy is typically symmetric in distribution, involving the hilar, paratracheal, aortopulmonary window and subcarinal regions (Fig. 1C, Fig. 8C). Lymph nodes may calcify (Fig. 1C, Fig. 8C), with the morphology of calcifications being dense, hazy or eggshell.

· Intracranial involvement:

Clinically silent involvement of the CNS occurs in approximately 25% of patients with sarcoidosis [3], but only 10% of all patients with sarcoidosis present with neurologic symptoms [3]. CNS involvement can precede the diagnosis of sarcoidosis and may be initially suggested by imaging. Within the CNS the disease has a propensity to involve the basal meninges, cranial nerves, pituitary-hypothalamic axis, optic chiasm and the perivascular Virchow-Robin spaces.

The involvement of the pituitary-hypothalamic axis may be one of the first disease manifestation in form of diabetes insipidus (up to 90% of patients) and symptoms related
to hyperprolactinemia, amenorrhea (patient in Fig. 5) or panhypopituitarism [4]. Pituitary involvement may be present as enhancing intrasellar mass with suprasellar extension, abnormal enlargement and enhancement of the infundibulum (Fig. 5F, Fig. 9 C-F) and infiltrative enhancing lesions of the hypothalamus (Fig. 3). Additionally, a lack of the normal T1-weighted hyperintense signal of the posterior pituitary, related to the absence of vasopressin-containing granules, the so called "loss of bright spot", can be present. There can be adjacent leptomeningeal enhancement (Fig. 3).

**Leptomeningeal involvement** is the most common manifestation of neurosarcoidosis. It has a predilection to involve the basal meninges, most commonly the suprasellar and frontal meninges [4](Fig. 4) and present as nodular thickening and enhancement on contrast enhanced T1-weighted images. There may be disruption of the blood-brain barrier, which may result in spread of disease along the cortical sulci, perivascular spaces and the cisterns around the base of the brain [1]. **Dural involvement** is less frequent and shows diffuse dural thickening or focal dural masses with homogeneous enhancement (Fig. 4A).

**Cranial nerve involvement** can be seen isolated or in association with leptomeningeal disease. Imaging findings and clinical symptoms can be conflicting, with cranial nerve deficits not being positive on imaging or with clinically silent positive imaging findings [4]. Sarcoidosis can involve the optic nerve and sheath, this being the second most commonly affected cranial nerve after the facial nerve. Patients can present with decreased vision or vision loss, which is sometimes rapid and painful [4]. MRI reveals enhancement, thickening or atrophy and increased T2-weighted signal of the optic nerve (Fig. 5 A-D), as well as thickening, nodularity and enhancement of the nerve sheath ("tram-track sign"). The abnormal signal and enhancement of the nerve can extend from the head of the nerve intracranially to the chiasm (Fig. 6), optic tracts and optic radiations [4]. The findings are not specific and the differentiation from neoplastic or chronic inflammatory changes cannot rely on imaging alone (patient in Fig. 5).

**Involvement of the sinonasal cavities** is rare and the radiological manifestations comprise nodular lesions of the nasal septum and inferior turbinates, mucosal thickening and partial or total opacification of the paranasal sinuses, sometimes with associated osteosclerosis (Fig. 7) [4]. **Osseous involvement** of sarcoidosis is seen in approximately 13% of patients with sarcoidosis, with the skull rarely being involved [5]. Lesions are most commonly lytic (Fig. 9A-B), but may appear as mixed or sclerotic on CT. There may be associated soft-tissue component [5]. Patients with neurosarcoidosis may also rarely present with cerebrovascular manifestations such as parenchymal or subarachnoid hemorrhage and stroke. Involvement of the larger venous sinuses has also been reported [6].

Optimal therapy can achieve clinical remission with variable improvement in imaging findings (Fig. 9C-F).
Langerhans cell histiocytosis

· Definition:

The histiocytosis are rare disorders characterized by the accumulation of macrophage, dendritic cell, or monocyte-derived cells in various tissues and organs [7]. Langerhans cell histiocytosis (LCH) is the most common histiocytic disorder and is characterized by granulomatous lesions comprising langerin-positive (CD207+) histiocytes [8]. LCH includes a broad spectrum of clinical manifestations in children and adults, ranging from self-healing to life-threatening disseminated disease. The diagnosis of LCH is based on clinical and radiological findings in combination with histopathological analyses identifying tissue infiltration by histiocytes (Fig. 12 and 13). LCH may affect any organ of the body.

In children, the lungs are affected in 15% of the patients, while pituitary gland involvement is more frequently seen in 25% of cases and the CNS involvement, excluding the pituitary, is extremely seldom (2-4%) [7]. In adults, lung involvement is more frequent than in children. Lung LCH of the adult is strongly associated with smoking and occurs predominantly in men.

· Thoracic involvement:

On HRCT of the lung the appearance of LCH varies with the stage of the disease. In early cases small scattered lung nodules with soft tissue attenuation are seen. Over the time these have the tendency to cavitate with formation of thick-walled lung cysts which tend to have irregular, bizarre shapes (Fig. 10, 11). Thus, a combination of nodules, cavitary nodules and cysts can be seen. Late disease may present with cysts that nearly replace the entire lung parenchyma, necessitating lung transplantation. These abnormalities present an upper lobe predominance with relative sparing of the lung bases and costophrenic angles. As with any cystic lung disease, the initial presentation may be due to the development of a pneumothorax.

· Intracranial involvement:

Intracranial LCH lesions affect the skull, meninges, hypothalamic-pituitary region and are sometimes associated with neurodegeneration.

The hypothalamic-pituitary axis is, by far, the most frequently involved intracranial region in LCH with the resulting clinical manifestation of diabetes insipidus. The imaging findings include an enhancing thickening of the pituitary stalk, greater than 3 mm, accompanied by the "loss of bright spot" (Fig. 12B) [9]. Also, atrophy (Fig. 12A-C) and threadlike narrowing of the infundibulum with a maximum width less than 1 mm can be seen. The LCH-associated pineal gland abnormalities comprise solid masses or cystic lesions [10]. Space occupying tumorous lesions can occur rarely in the meninges, choroid plexus and in the brain parenchyma [10].
Cranial-facial involvement with osseous lesions in the bones of the orbits and calvaria is a classical presentation of LCH. They present as punched out osteolytic lesion with scalloped edges and soft tissue involvement (Fig. 14). They produce full thickness bone destruction. It was also shown that opacification in the paranasal sinuses or mastoids (Fig. 15) was more frequent in LCH patients than in controls [9].

Another presentation of CNS LCH is a combination of pathologic changes in the cerebellum, basal ganglia and/or pons with characteristic MRI patterns "radiological neurodegeneration" [11]. Some patients present with subtle hyperintensity of the dentate nucleus on T1-weighted images (Fig. 12 D and Fig. 16A). The dentate nucleus develops a hyperintensity on T2 weighted images, with subsequent extension of this T2 weighted hyperintensity to the perinuclear white matter over months and years [9, 11]. In the basal ganglia the abnormalities consist of hyperintense signals on T1-weighted images, usually involving globus pallidum (Fig. 12E, Fig. 16B-C). The increase of signal intensity abnormalities in the cerebellum and basal ganglia does not correlate with neurologic deterioration [11].

Lymphangioleiomyomatosis

- Definition:

Lymphangioleiomyomatosis (LAM) is a rare multisystem disease predominantly affecting women of childbearing age. Most LAMs are sporadic (S-LAM), but they can also occur in association with tuberous sclerosis complex (TSC-LAM), an autosomal dominant disorder with variable penetrance associated with neurologic, renal and cutaneous manifestations. LAM predominantly affects the lungs, but can also occur along the axial lymphatic system, including the lymph nodes in the mediastinum, retroperitoneum, pelvic cavity and thoracic duct [12].

- Thoracic involvement:

Characteristic HRCT features of LAM include the presence of multiple, bilateral, round, well-defined, relatively uniform, thin-walled cysts in a diffuse distribution (Fig. 17 A-C). The intervening lung parenchyma often appears normal on HRCT. Other associated features that can be seen on HRCT in some patients with LAM include the presence of: chylous pleural effusion, pneumothorax (Fig. 17A, C), ground-glass opacity suggestive of chylous congestion, or multiple tiny nodules characteristic of multifocal micronodular pneumocyte hyperplasia (MMPH, in patients with TSC-LAM, Fig. 19 A-Band Fig. 20) [13]. Another characteristic finding in TSC-LAM is the presence of angiomyolipomas (AML) of the kidney. The diagnosis of AML can usually be made on the basis of the presence of fat in the tumors (Fig. 17D) [13].

- Intracranial involvement:
Because of the relatively high frequency of TSC-LAM, routine brain screening with MRI and computed tomography is performed for evidence of TSC in patients with LAM. Patients with documented TSC manifests within the brain with cortical or subcortical tubers, subependymal nodules, subependymal giant cell astrocytoma, cortical dysplasia and white matter abnormalities.

**Cortical tubers** are benign hamartomas in the cerebral cortex, typically appearing on MRI as well-circumscribed or voluminous areas of low signal intensity on T1-weighted and high signal intensity on T2-weighted sequences (Fig. 18B-C and Fig. 19C-D). In children, initially the signal intensities are high on T1-weighted and low on T2-weighted sequences and they change over the time because of the progressive myelination. **Subependymal nodules (SEN)** are hamartomatous lesions lining the ventricular walls that can degenerate into **subependymal giant cell astrocytomas (SEGA)**. They can show calcifications on CT (Fig. 18 A-B). Due to the compressive effect, SEGAs localized in the region of foramen Monro can produce ventricular obstruction and hydrocephalus. The white matter abnormalities can reveal radial migration lines (radial bands) stretching from the periventricular white matter to the subcortical region (Fig. 18C-D) [14]. Extremely seldom, in patients with LAM extraaxial tumor masses with morphological characteristics of meningiomas are found (Fig. 18E) [15].

**Vasculitis**

· **Definition:**

Systemic vasculitides are idiopathic diseases causing an inflammatory injury to the vessel walls with vessel destruction. Their classification is based on the size of vessels principally involved (large, medium and small). Three main immunological mechanisms of vessel damage have been identified: deposition of immune complexes, antibody-mediated and/or cell-mediated immunity and granulomatous reaction. In addition, vasculitis may be associated with systemic connective tissue disorders, like lupus vasculitis.

· **Thoracic involvement:**

Pulmonary involvement can be identified in all systemic vasculitides, however it tends to include small vessels inflammatory processes, Behcet disease or lupus vasculitis. The abnormalities can affect any anatomical or functional component of the lung: vessels (pulmonary and/or systemic), parenchyma, airways (trachea and bronchi) and pleura [16]. Lung involvement is suggested by a pattern of **diffuse or focal ground glass opacities reflecting pneumonitis or alveolar hemorrhage** (Fig. 27), **nodules or masses with or without cavitation** (Fig. 24B-D), **parenchymal consolidations** (Fig. 21), **tracheal or bronchial abnormalities** (wall thickening, Fig. 21B, and stenosis), **vascular abnormalities** (aneurysms, wall thickening, stenosis and inflammation), **reticulonodular pattern** (Fig. 26A) and **pleural disease** (Fig. 21, Fig. 24, Fig. 28) [16].
Intracranial involvement:

The clinical course of cerebral vasculitis ranges from fulminant to indolent and may be marked by fluctuations in clinical sign. While some patients present with normal cerebral MRI scan, most of them show changes such as multiple small intraparenchymal (gray or white matter) lesions consistent with ischemic stroke (Fig. 22, Fig. 23A-D, Fig. 25 A-D). These lesions do not have a periventricular predilection. Small petechial hemorrhages (Fig. 25E-G) or larger areas of hemorrhage or infarction (Fig. 28E-F) may also be found. Some patients may have enhancement of the meninges or of the small penetrating arteries. The cerebral arteries may demonstrate a beaded appearance with variable degrees of stenosis or occlusion (Fig. 23G-H) and contrast enhancement of the vessel walls (Fig. 23E-F). Because most inflammatory vasculitides affect small to medium caliber arteries, the results of MR angiography of the brain may often also be normal (Fig. 25H) [17, 18]. In younger patients under the age of 45 years, lesions demonstrated by MRI are likely to represent changes associated with vasculitis, especially if the cortex or the corticomedullary junction is involved and if the number of small focal hyperintense lesions is high (Fig. 26 B-C) [19].
Fig. 1: 51-year-old man with histologically proven sarcoidosis. Clinically the patient presented with chronic rhinitis, blurred vision, visual field defect and exertional dyspnea. Axial maximal intensity projection (A), and coronal (B) HRCT images showing scattered nodules with peribronchovascular (red arrowheads) and subpleural (white arrowheads) distribution. Coronal (C) CT image at the level of mediastinum presenting symmetric lymphadenopathy with some dense calcifications.

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Fig. 2: Histologic specimen from lung biopsy (same patient as in Fig. 1) showing relatively well-defined, non-necrotizing, epithelioid-histiocytic sarcoidosis-type granulomas (A) and magnification of a granuloma with multinucleated giant cells of the Langerhans type, and lymphocyte infiltrates surrounding the granuloma (B). hematoxylin/eosin staining, original magnification 40x (A) and 100x (B).

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**Fig. 3:** Same patient as in Figure 1. Sagittal T2-weighted (A), axial FLAIR (B) and sagittal contrast-enhanced T1-weighted (C-F) images of the brain showing pathological hyperintense signal and enhancement involving the pituitary-infundibulum-hypothalamus axis (dashed circles). Of notice is the adjacent leptomeningeal disease.

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**Fig. 4:** Same patient as in Figure 1. A and B, sagittal contrast-enhanced T1-weighted images showing nodular leptomeningeal (red arrows) and dural (white arrowheads) enhancement.

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Fig. 5: 32-year-old woman with sarcoidosis who presented with blurred vision which rapidly developed into amaurosis, and difficulties of color discrimination in the right eye. Axial FLAIR (A), coronal fat saturated T2-weighted (B), and axial T1-weighted images before (C) and after (D) gadolinium administration showing increased signal, enhancement and enlargement of right optic nerve (white arrowheads). The patient was initially suspected to have an optic glioma, but the pathological result after resection of the nerve showed sarcoidosis. Four years later the patient developed a mild hyperprolactinemia with galactorrhea and amenorrhea. In the control brain MRI there was a new developed nodular thickening of the pituitary stalk (E, F, sagittal T1-weighted contrast enhanced images, red arrowhead).

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**Fig. 6:** Same patient as in Figure 1. Coronal T2-weighted and contrast enhanced T1-weighted images revealing increased signal, enhancement and enlargement within the optic chiasm.

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**Fig. 7:** Same patient as in Figure 1. Axial FLAIR (A), contrast-enhanced T1-weighted (B) images showing heterogeneous intermediate signal bilateral polypoid lesions (red arrowhead) with contrast enhancement filling nasal cavities, as well as mucosal thickening (white arrowhead) of the ethmoid and right sphenoid sinus. Additional CT (C, bone window) depicts chronic sclerotic bony changes and opacification of the ethmoid and sphenoid sinus.
Fig. 8: 29-year-old man with sarcoidosis who presented with uveitis, as well as cervical and axillary lymphadenopathy. No respiratory symptoms. Axial HRCT (A, B) images displaying pribronchovascular (red arrowheads) and subpleural nodules (white arrowheads). Coronal CT (C) image in mediastinal window showing partially calcified mediastinal lymphadenopathy as well as axillary lymphadenopathy (dashed circles).
**Fig. 9:** Same patient as in Figure 8. CT of the skull (bone window) reveals the presence of lytic lesions involving the frontal and parietal bones (dashed circles). On the brain MRI coronal T2-weighted (C, E and F) and contrast enhanced T1-weighted (D) images show an enhancing lesion of the pituitary stalk just underneath the optic chiasm. At control MRIs the lesion vanished.

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Fig. 10: 27-year-old man with LCH presenting with recurrent pneumothorax and respiratory insufficiency. Axial (A) and coronal (B and C) HRCT showing irregularly shaped cysts with variable thickness of the wall. The distribution of the cysts is predominantly in the upper lobes. Pneumothorax on the right side and bilaterally pleural drainage. The clinical condition of the patient deteriorated rapidly because of bilaterally recurrent pneumothoraxes and he necessitated lung transplantation.

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Fig. 11: 18-month-old boy with multisystemic LCH. The CT of the lung (A, axial, B and C coronal) shows bilaterally multiple irregularly shaped and clustered cysts, the costophrenic angles are not spared in this case.

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**Fig. 12:** 8-year-old girl with multisystemic LCH with diabetes insipidus, neurodegeneration and lytic bony and skin lesions. Five years previous to this examination the patient presented a mass lesion of the pituitary stalk. Now the brain MRI shows an atrophy of the pituitary gland with the absence of the "bright spot" of the neurohypophysis (sagittal T2-weighted, A and T1-weighted images before and after gadolinium, B and C). Axial T1-weighted images at the level of dentate nucleus (D) and of the basal ganglia (E) showing subtle hyperintense signal alterations corresponding to radiological neurodegenerative LCH.

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Fig. 13: Histologic specimen from a skin biopsy (same patient as in Figure 12) showing (A) in the dermis dense infiltrates of histiocytic cells and abundant eosinophilic granulocytes, hematoxylin/eosin staining, original magnification 40x. (B) 100x magnification depicting the histiocytic cells with nuclear infoldings and grooves as well as characteristic "crumpled tissue paper" nuclear outlines. Abundant eosinophilic granulocytes.

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Fig. 14: 16-year-old boy with a singular lytic bony lesion of the frontal bone. Axial CT (A, bony window), coronal T2 weighted (B) and fat saturated contrast enhanced T1 weighted (C) MR images showing the osseous destruction with a soft tissue component.

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Fig. 15: 61-year-old female patient with multisystem LCH showing a massive mastoid involvement with opacification and lytic osseous lesions in CT (A), with consecutive bony destruction and erosion of the semicircular canals. The MRI, axial FLAIR (B) and coronal T2 (C) depicts the bilateral hyperintense signal alteration of the mastoid.

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Fig. 16: 18-year-old boy with neurodegenerative LCH. Axial T1-weighted images of the dentate nucleus of the cerebellum (A) and basal ganglia (B and C) also depicting hyperintense signal alterations.

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Fig. 17: 21-year-old woman with tuberous sclerosis complex. Axial (A and B) and coronal (C) HRCT images presenting scattered round thin-walled cysts with diffuse distribution. Right sided pneumothorax. CT of the abdomen (D) shows fat-containing renal masses (dashed circles) which were histologically proven to be angiomyolipomas.

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**Fig. 18:** A-D same patient as in Figure 17. CT of the brain (A) with calcified lesions at the level of interventricular foramen of Monro (white arrowheads) consistent with SEN/SEGAs. Axial FLAIR (B) image reveals bilateral subcortical hyperintense lesions representing subcortical tubers (white arrowheads). SEN are also present (red arrowheads). Axial FLAIR (C-D) images showing high signal intensity radial bands spanning from the periventricular white matter to the subcortical region. Axial contrast enhanced T1 (E) image of another patient with LAM presenting an avidly and homogeneously enhancing mass lesion in the middle cranial fossa with mass effect and contact to the sphenoid wing, consistent with a meningioma.

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Fig. 19: 26-year-old woman with tuberous sclerosis complex. Axial chest CT (A and B) shows multiple bilateral small ground-glass opacities, histologically proven as multifocal micronodular pneumocyte hyperplasia (MMPH) associated with atypical adenomatous hyperplasia. No cystic changes. On the brain MRI (FLAIR sequence, C and D) subcortical tubers can be distinguished.

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**Fig. 20:** Histologic specimen from lung biopsy (same patient as in Figure 19) showing MMPH with micronodular lesions with pneumocyte hyperplasia with low cytological atypia, slightly widened alveolar walls with lymphomonocytic inflammatory cells and intra-alveolar macrophages (A, hematoxylin/eosin staining, original magnification 40x). (B) Magnification of the image in (A) (100x). (C) Enlargement of another micronodular lesion with slightly fibrotic widened alveolar walls and pneumocytic hyperplasia with variable cytological atypia (100x). (D) Magnification of the image in (C), 200x.
**Fig. 21:** 73-year-old man with eosinophilic granulomatosis with polyangiitis with history of exertional dyspnea and Wallenberg syndrome. Axial (A-C) and coronal (D) CT images showing pleural thickening, peripheral parenchymal consolidation (red arrowheads), nodular bronchial wall thickening (white arrowheads), ground glass opacities and reticular pattern in the lower lobes.

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Fig. 22: Same patient as in Figure 21. Axial diffusion-weighted (A) and FLAIR (B), as well as coronal T2-weighted (C) images revealing a small area in the right medulla oblongata with restricted diffusion and high signal consistent with subacute ischemic lesion, as morphologic substrate for the Wallenberg syndrome.

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Fig. 23: Same patient as in Figure 21, MRI performed two years later. Axial diffusion-weighted (A-B), and corresponding FLAIR (C-D) images showing multiple scattered right hemispheric lesions with increased signal intensity and diffusion restriction involving the cerebral cortex and gray-white matter interface consistent with small infarcts. Coronal
flow-compensated T1-weighted images before (E) and after contrast enhancement (F), time-of-flight angiography (G) and time-to-peak perfusion (H) images displaying wall-enhancement and a corresponding significant stenosis of the left middle cerebral artery (MCA, white arrowhead) at the border between M1 and M2 segments, as well as subsequent significant decreased perfusion in the MCA territory.

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**Fig. 24:** 32-year-old woman with systemic lupus erythematosus with newly developed epileptic seizure. Axial CT in mediastinal window (A) reveals enlargement of the main pulmonary artery as a sign of pulmonary hypertension. Axial CT images in lung windows (B-D) show nonspecific findings consisting of pleural effusion, nodules and ground glass opacities, which could represent edema, diffuse alveolar damage (DAD), infection or hemorrhage. The degree of pulmonary hypertension (the measured systolic pulmonary artery pressure (sys PAP) was 96 mmHg) is out of proportion to the severity of lung findings, suggesting vasculitis.

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Fig. 25: Same patient as in Figure 24. Axial FLAIR (A-B) and corresponding diffusion-weighted (C-D) images presenting multiple cortical patchy areas of hyperintensity with diffusion restriction suggestive of CNS vasculitis. Axial blood sensitive sequence (E-G) shows multiple petechial hemorrhages with predominantly peripheral distribution. The time-of-flight angiography (H) is unremarkable.

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Fig. 26: 43-year-old woman with systemic lupus erythematosus with history of acutely developed psychotic syndrome and depression. Axial CT (A) image of the lung depicts subpleural and basilar predominant ground glass opacities with the histological result of lupus pneumonitis with organizing pneumonia. The brain MRI (B and C, axial FLAIR images) revealed extensive, diffuse, over bilateral cerebral hemispheres scattered areas
of hyperintense signal not appropriate to the age of the patient and suggestive of vasculitic changes.

Fig. 27: Histologic specimen from lung biopsy (same patient as in Fig. 26) with (A-B) diffuse alveolar damage with signs of organization, increased mononuclear cells in widened alveolar wall, diffuse alveolar hemorrhage and siderophages (magnification 100x). (C) Image of the pleura with fibrin deposition (40x). (D) intra-alveolar fibrin with fresh erythrocytes (100x). Hematoxylin/eosin staining.
Fig. 28: 25-year-old woman with systemic lupus erythematosus and secondary antiphospholipid syndrome with arterial embolism and amputation of the left arm. She presented with respiratory insufficiency. The lung CT shows an extensive enlargement of the pulmonary artery (A, mediastinal window, measured systolic PAP was 60 mm Hg), as well as diffuse patchy ground glass opacities with bronchial wall thickening (red arrowheads) and pleura effusion, again nonspecific findings which could represent edema, DAD, infection or hemorrhage. A previous lung biopsy indicated a necrotizing capillaritis with erythrocytic extravasation. The brain MRI (axial T2-weighted images E and F) revealed extensive symmetric bilateral regions of increased signal intensity in the white matter and cortical destruction consistent with old dorsal watershed infarcts.

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Conclusion

DPLDs as manifestation of systemic disease should prompt a careful diagnostic search for additional intracranial specific lesions in the presence of neurological symptoms.


