Calcifying lesions and pseudolesions of the neuroaxis with focus on CAPNON

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- **Purpose**: Many different intracranial lesions demonstrate dense calcifications and neuroimaging plays a vital role in characterization and diagnosis. The purpose of this educational exhibit is to offer a review of the uncommon histologic entity called calcified pseudoneoplasm of the neuroaxis (CAPNON) and to provide a differential diagnosis and several example cases of other calcified lesions of the neuroaxis to help the reader differentiate and distinguish CAPNON from more common neoplastic and non-neoplastic lesions.
- **Background**: CAPNON lesions are rare, benign, non-neoplastic lesions that may occur anywhere in the neuroaxis, either intra-axial or extra-axial, and are often intracranial in location. There is no sex or age predilection and patients often present with symptoms based on lesion location due to local mass effect, cranial neuropathy, seizure or headache. Patients may also be asymptomatic and lesions can be discovered incidentally.
- **Imaging findings**: CAPNON lesions demonstrate dense often well circumscribed calcifications on CT, with associated T1 and T2 hypointense signal on MRI and susceptibility signal loss that corresponds to calcification. There is not significant peri-lesional brain parenchymal edema and minimal to absent contrast enhancement. When enhancement is present it is most commonly faint curvilinear corresponding to fibrovascular stroma.
- **Histological findings**: CAPNON lesions are composed primarily of mesenchymal tissue with mixed fibro-osseous components, often with dystrophic calcifications and psammoma bodies. Nodular chondromyxoid material with osseous metaplasia, peripheral palisading spindle/epitheliod cells along the margins of the lesions as well as patchy areas of chronic inflammatory fibrovascular stroma can also be seen. Mitotic activity is usually absent or very sparse. There may also be a foreign body reaction with giant cells.
- **Differential diagnosis**: A broad, but not exhaustive differential diagnosis for a densely calcified lesion with distinguishing features that often depend on lesion location and morphologic characteristics is shown on table 1 below.

Table 1. Differential Diagnosis of Calcified Lesions of the Neuroaxis.

Location	Example		Helpful distinguishing features
Extra-axial		Meningioma	Dural based mass with avid enhancement.
		Chondrosarcoma	Heterogenous T2 hyperintense lesion with patchy enhancement and chondroid matrix on CT.
Intra-axial	Neoplasm	Oligodendroglioma, ganglioglioma, glioma or other tumor	Masses may demonstrate varying degrees of contrast enhancement or peri-lesional edema. Dense calcification alone would be an unusual appearance for neoplasm.
	Vascular	Aneurysm	Continuous with an artery.
		Cavernous malformation	Heterogenous popcorn appearance with marked susceptibility signal loss due to hemosiderin.
	Infectious	CMV, Herpes Simplex	Often encephalomalacia with curvilinear calcifications at site of remote infection.
		Neurocysticercosis	Nodular calcified stage - multiple small dormant lesions scattered through out the brain.
	Inflammatory	Sarcoidosis	Most commonly leptomeningeal enhancement with rare curvilinear calcifications. Dense calcifications would be unusual.
	Congenital	Sturge-Weber	Curvilinear gyriform calcification corresponding to pial angioma.
		Tuberous Sclerosis	Calcified cortical tubers or subependymal nodules
	Dysplastic	Hamartoma	Occasionally can appear as a quiescent lesion without significant mass effect or enhancement. May be indistinguishable from CAPNON.
	Metabolic	Fahr's syndrome	Dense bilateral basal ganglia, dentate nuclei and white matter calcifications.
		Hyperparathyroidism	Symmetric bilateral basal ganglia calcifications due to chronic hypercalcemia.
Intra-ventricular		Choroid plexus neoplasm	Heterogenous intraventricular mass that often demonstrates avid enhancement.
		Meningioma	Avidly enhancing calcified mass.
Spinal		Calcified disc fragment	Peripherally calcified and usually continuous with intervertebral disc.
		Meningioma	Avidly enhancing dural based calcified mass.

Calcified pseudoneoplasm of the neuroaxis (CAPNON)

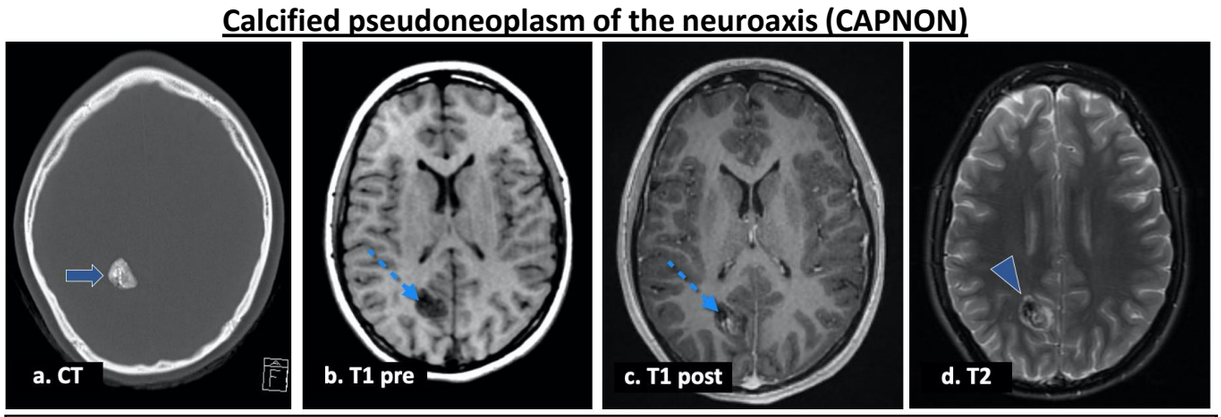

Figure 1. 13 year old with seizures. Axial head CT obtained in the ER shows a densely calcified lesion in the right parietal region (a) (arrow). Follow up axial T1 pre and post contrast MRI demonstrates a T1 hypointense lesion with mild curvilinear contrast enhancement (b,c) (dashed arrow). Axial T2 MRI images primarily T2 hypointense signal in the lesion with susceptibility signal loss due to calcifications with minimal surrounding T2 hyperintense signal/edema (d) (arrow head).

Calcified pseudoneoplasm of the neuroaxis (CAPNON)

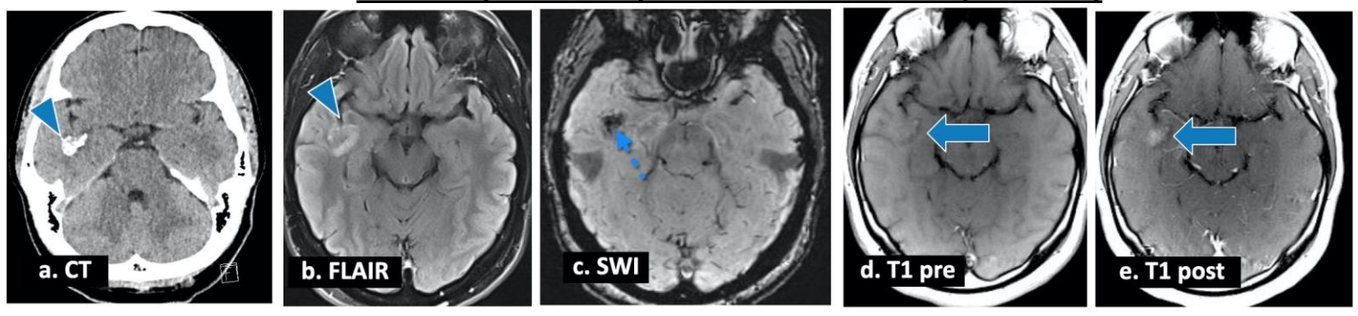

Figure 2. 47 year old with headache. Axial CT shows a densely calcified lesion in the left temporal lobe (a)(asterisk). Axial FLAIR demonstrates a mildly FLAIR hyperintense lesion with minimal surrounding parenchymal edema (b) (arrow head). There is marked susceptibility signal loss corresponding to calcifications on SWI images (c) (dashed arrow). Axial pre (d) and post (e) contrast T1 images demonstrate very mild amorphous contrast enhancement within the lesion (arrows).

Chondrosarcoma

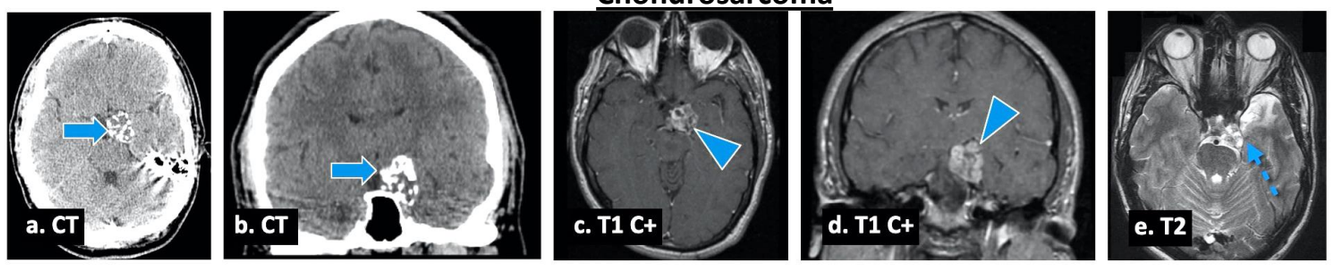

Figure 3. 38 year old with worsening vision in left eye. Axial (a) and coronal CT (b) demonstrate an exophytic partially calcified heterogenous mass with ring and arc matrix adjacent to the left posterior clinoid process (arrows). Axial (c) and Coronal (d) contrast enhanced T1 images show heterogenous enhancement with curvilinear hypodensities that correspond to areas of calcification (arrow heads). The T2 signal demonstrates heterogenous hyperintensity with areas of low intensity corresponding to calcifications (e) (dashed arrow).

Oligodendroglioma

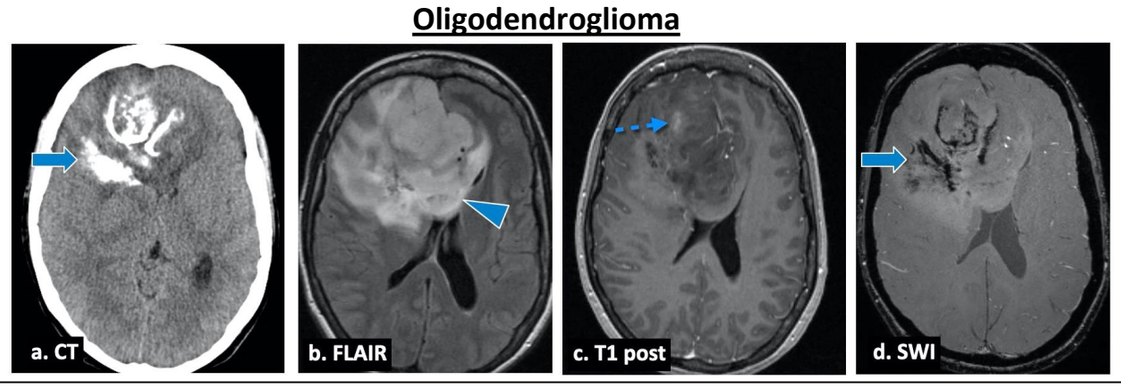

Figure 4. 23 year old with seizure, behavioral changes and headache. Axial CT shows a large left frontal mass with curvilinear internal calcifications (a)(arrow). MRI demonstrates a large T2/FLAIR hyperintense mass (b) with mild peri-lesional edema (arrowhead), minimal curvilinear contrast enhancement (c) (dashed arrow) and susceptibility signal loss corresponding to macro-calcifications (d)(arrow).

Meningioma

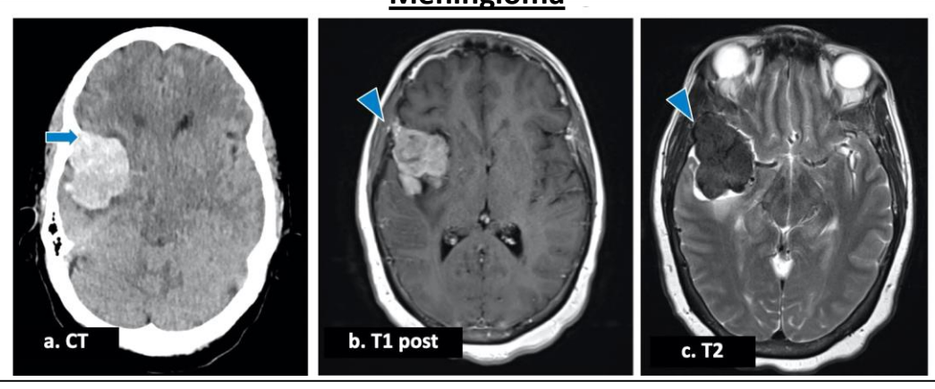

Figure 5. 57 year old with history of enlarging meningioma. Axial head CT shows a dural based densely calcified lesion in the extra-axial right temporal region (a) (arrow). Axial T1 post contrast MRI demonstrates avid enhancement in the mass (b)(arrow head). Axial T2 MRI shows marked T2 hypointensity corresponding to macroscopic calcifications within the lesion (c) (arrow heads).

- **Summary**

CAPNON is a rare densely calcified non-neoplastic lesion that may occur anywhere in the neuroaxis, with marked T1 and T2 hypointense signal, minimal enhancement and no significant adjacent brain edema. These lesions can result in symptoms based on mass effect, serve as a seizure focus, could be a source of chronic headache, or could be found incidentally. Calcified lesions with heterogenous T2 hyperintense signal or avid contrast enhancement are more likely to be a neoplastic and inconsistent with CAPNON. It is essential that radiologists understand imaging features and the distinguishing features of other calcified intracranial lesions to narrow diagnostic considerations and help guide management decisions.

- **References**

Aiken AH, Akgun H, Tihan T, Barbaro N, Glastonbury C. Calcifying pseudoneoplasms of the neuraxis: CT, MR imaging, and histologic features. *AJNR Am J Neuroradiol.* 2009 Jun;30(6):1256-60. doi: 10.3174/ajnr.A1505. Epub 2009 Apr 15.

Baram TZ, van Tassel P, Jaffe NA. Brain metastases in osteosarcoma: incidence, clinical and neuroradiological findings and management options. *J Neurooncol*. 1988;6(1):47-52.

Brasiliense LB, Dickson DW, Nakhleh RE, Tawk RG, Wharen R. Multiple Calcifying Pseudoneoplasms of the Neuraxis. *Cureus*. 2017 Feb 21;9(2):e1044. doi: 10.7759/cureus.1044.

García Duque S, Medina Lopez D, Ortiz de Méndivil A, Diamantopoulos Fernández J. Calcifying pseudoneoplasms of the neuraxis: Report on four cases and review of the literature. *Clin Neurol Neurosurg.* 2016 Apr;143:116-20. doi: 10.1016/j.clineuro.2016.02.025. Epub 2016 Feb 23.

Ginsberg LE. Radiology of meningiomas. *J. Neurooncol*. 1996;29 (3): 229-38.

Koeller KK, Rushing EJ. From the archives of the AFIP: pilocytic astrocytoma: radiologic-pathologic correlation. *Radiographics.* 24 (6): 1693-708.

Koeller KK, Rushing EJ. From the archives of the AFIP: Oligodendroglioma and its variants: radiologic-pathologic correlation. *Radiographics*. 2005;25 (6): 1669-88.

Nadgir R, Yousem DM. Neuroradiology: the Requisites. Philadelphia, PA: Elsevier; 2017.

Osborn AG, Hedlund GL, Salzman KL. Osborns Brain: Imaging, Pathology, and Anatomy. Philadelphia, PA: Elsevier; 2018.