Imaging of Brain Masses: Tumor and Tumor Mimics
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Background:
The term tumor is derived from the Latin word for "swelling" – tumor and is not synonymous with cancer/neoplasm. A number of brain pathological processes can present as large, single, tumefactive masses which mimic a brain neoplasm on morphologic imaging. Additional clinical information, patient presentation, signs and symptoms as well as follow up imaging can help differentiate most of the non-neoplastic lesions from neoplasms. However, many of these present with significant mass effect as well as patient and physician anxiety to make a correct diagnosis in order to institute correct therapy and hence, most of these cases will undergo additional functional imaging that can help generate additional metabolic or physiologic information.

Learning Objectives:
The purpose of this presentation is to

1) To familiarize the audience with various brain pathologies which can present as a mass or tumor on the initial clinical as well as imaging presentation, but may not be a neoplasm. These include but are not limited to infections (abscesses/granulomas), stroke (ischemic or hemorrhagic), vasculitis/angitis, inflammatory/granulomatous disease processes, tumefactive demyelinating lesions as well as giant tumefactive Virchow Robin spaces.

2) To discuss the limitations of morphologic imaging features including contrast enhancement, edema, and mass effect.

3) To discuss the role of functional imaging techniques such as metabolic (MR spectroscopy, PET) and physiologic (DWI, Perfusion) imaging modalities can play in differentiating these non-neoplastic mimics from brain neoplasms with reference to physiologic differences between the two.

Material and Methods:
Clinical cases from personal teaching files as well as pertinent references from the published literature will be presented to show examples of various tumor mimics as well as various functional imaging modalities used to differentiate non-neoplastic lesions from neoplasms. Examples like figure 1 will be shown with detailed clinical information/follow up, serial imaging, and utilization of functional imaging techniques.

Discussion:
Most of these non-neoplastic brain tumor mimics can be differentiated from brain neoplasms based on clinical presentation and temporal evolution of these on serial or follow up imaging. However, conventional morphologic imaging features may not be sufficient in many of these cases as most of these lesions will show contrast enhancement (due to blood brain barrier breakdown), necrosis, edema and mass effect (Fig 1) and hence, will need advanced imaging such as DWI, MR spectroscopy and perfusion imaging to differentiate from neoplasms.

Cystic necrotic neoplasms can be easily differentiated from brain abscesses using DWI as brain abscesses will typically show restricted water diffusion in the cystic necrotic part. MR spectroscopy has also been used in the past to differentiate cystic necrotic neoplasm from abscess (based on increased amino acids peaks seen in abscesses) or from tubercular granulomas (showing increased lipid/lactate).

Figure 1 A, B, C and D: Post-contrast T1-weighted images in 4 different patients --- Which one of these is not a neoplasm?
Most of the neoplasms will show increased choline (increased choline/creatine or choline/NAA ratios) which is a marker of increased cell membrane turnover. However, some of the actively demyelinating tumefactive lesions can also show increased choline levels and MR spectroscopy thus may not be helpful. Whereas most of the non-neoplastic lesions (including tumefactive demyelinating lesions) will show decreased blood volume compared to brain neoplasms and hence, perfusion imaging could be helpful in such a scenario. Brain neoplasms show increased blood volume due to higher microvascular density and angiogenesis, whereas most of non-neoplastic lesions will have lower blood volume compared to high-grade neoplasms which they usually mimic based on contrast enhancement, central necrosis, edema and mass effect.

**Conclusion:**

In conclusion, it is important to differentiate brain neoplasms from non-neoplastic tumefactive lesions in order to implement correct treatment regimen in a timely manner which could be important in high grade neoplasms where any time lost to initiate treatment could adversely affect patient prognosis. Additional clinical information and follow up imaging can help, but utilizing advanced imaging techniques to assess the physiologic and metabolic state of these lesions could help save the day.

**References:**