MAGNETIC RESONANCE IMAGING OF EXTRA-AXIAL TUMOR

Anggraini Dwi Sensusiati[1]

[1]*Departement of Radiology, Medical Faculty of Universitas Airlangga – Airlangga University Hospital, Surabaya*

PENCITRAAN *MAGNETIC RESONANCE* PADA TUMOR EKTRA-AKSIAL

ABSTRACT

The first step in making decision of intra-cranial tumors is the location of tumor, whether intra- or extra-axial. After localized the lesion we make differential diagnosis that relevant to the location. Once we made the decision, we make the characterization of the tumors. With MRI it is easier to make this decision compared to CT.

Meningiomas constitute the most common extra-axial tumors of the brain. Contrast-enhanced MRI can easily detect the location of the tumor, the full extension of the tumor, sinus invasion and/or thrombosis, vascularity, intra-cranial edema, and intra-osseous extension. WHO grades meningiomas in 3 types which are typical, atypical, and malignant meningioma. With structural MRI, MR Spectroscopy, MR perfusion and some methods we can grade this type.

Tumors of neurogenic origin such as schwannomas, neurofibromas, neuromas may be similar in appearance. MRI can help distinguishing these tumors with meningiomas. Another extra-axial lesion located in bone or arachnoid is metastases. Contrast-enhanced T2-FLAIR can easily detect these lesions, but inflammatory lesions may also simulate dural metastase. Other extra-axial tumors are choroid plexus masses, non-neoplastic masses (epidermoids, dermoids, teratomas, lipomas). The location as well as specific appearances on imaging will guide us to a specific diagnosis.

Keywords: intra-cranial tumor, extra-axial tumor, magnetic resonance imaging, meningioma

ABSTRAK

Langkah pertama dalam membuat keputusan mengenai tumor intra-kranial adalah menentukan lokasi tumor apakah intra- atau ekstra-aksial. Setelah melokalisasi lesi, diagnosis yang relevan dengan lokasi dapat dibuat. Karakterisasi tumor dilakukan setelah menentukan keputusan. Membuat keputusan mengenai tumor intra-kranial lebih mudah dilakukan menggunakan MRI dibandingkan dengan CT.

Meningioma merupakan tumor otak ekstra-aksial yang paling umum. MRI dengan kontras dapat dengan mudah mendeteksi lokasi tumor, perluasan tumor, invasi sinus dan/atau trombosis, vaskularisasi, edema intra-kranial, dan ekstensi intra-osseous. WHO menggolongkan meningioma dalam 3 tipe, yaitu tipikal, atipikal dan ganas. Dengan MRI struktural, MR spektroskopi, MR perfusi dan beberapa metode lain kita bisa menggolongkan tipe meningioma.

Tumor neurogenik seperti schwannoma, neurofibroma, neuroma mungkin serupa dalam tampilannya. MRI dapat membantu membedakan tumor ini dengan meningioma. Lesi ekstra-aksial lainnya yang terletak di tulang atau arachnoid adalah metastase. T2-FLAIR dengan kontras dapat dengan mudah mendeteksi lesi ini, namun lesi inflamasi dapat menyerupai metastasis dural. Tumor ekstra-aksial lainnya adalah massa pleksus choroid, massa non- neoplastik (epidermal, dermoid, teratoma, lipoma). Lokasi dan gambaran yang spesifik pada pencitraan akan membimbing kita pada diagnosis yang spesifik.

Kata Kunci: tumor intra-kranial, tumor ekstra-aksial, pencitraan magnetic resonance, meningioma

INTRODUCTION

In order to treat a brain tumor corectly, an assessment to characterize the tumor need to be done. When we analyze a potential brain tumor, many questions need to be answered. Patient's age is needed to be known since different tumors occur in different ages.[1,2] The tumor location, whether it is intra- or extra-axially or crossing the midline. Other important issues are which compartment it lies, eg. sellar or protosellar region and whether it is a solitary mass or multifocal disease.

MRI is very useful to evaluate a potential brain tumor by analizing the tissue character, including: (a) calcification, (b) fat, (c) cystic components, (d) blood, (e) contrast enhancement, and (f) signal intensity on T1W, T2W, and DWI.

Incidence of CNS Tumor

Extra-axial tumor is a tumor that arise from outside the brain substance, ie. at meningeal, dural, epidural or intra-ventricle.[3] The highest incidence of Central Nerve System (CNS) tumor is from gliomas (33%), while the least one is lymphomas (2%). Eventhough meningioma is not the most common of CNS tumors, it is quite frequent. Meningiomas themselves are in the second position of most common CNS tumors with 29% incidence **(Figure 1)**.

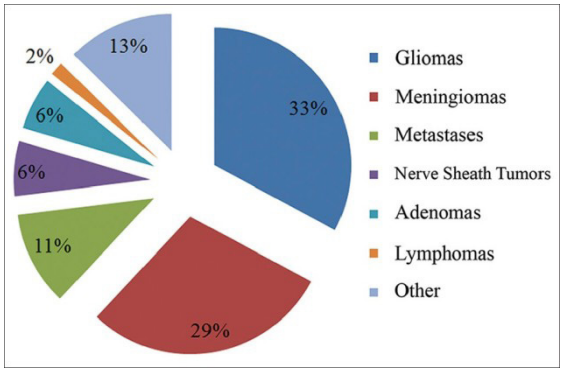

Figure 1. CNS tumor incidency[1]

The compartmental localization of intra-cranial masses is important and fundamental to the disease. It will determine the appropriate pathway for correct differential diagnosis and discussion. Knowing the location of the tumor will affects treatment planning and prognosis. However, location is not the only thing that affects the treatment planning. The nature of the tumor needs to be assessed too, eventhough most of extra-axial tumors are benign.

STEPS TO MAKE MR DIAGNOSIS

There are several steps needed to make appropriate MR diagnosis:

1. *Gather patient's data*
   Before doing any examination, the complete patient's data needs to be recorded. It includes patient's age, hormonal condition, tumor history, etc. Each of patient's data is needed to make the right diagnosis.

2. *Renal function*
   Assesment of Glomerular Filtration Rate (GFR) or serum creatinin is needed for the consideration of using contrast agents. On May 2007, there was an alert which warns against using any of the five approved Gadolinium-based MRI contrast agents in patients with acute or chronic renal failure with GFR < 30 mL/min "unless the information is essential and cannot be obtained with other imaging techniques".[4]

3. *Routine sequences*
   The routine sequences on MR evaluation includes axial T1W, T2W, FLAIR, DWI, ADC, FFE/Gre T2*, coronal T2W, and sagittal T2W.

4. *Contrast agent*
   The most commonly used compounds for contrast enhancement is Gadolinium-based. Such MRI contrast agents shorten the relaxation times of nuclei within body tissues following oral or intravenous administration. MRI Gadolinium contrast agents have not been proved safer than the iodinated contrast agents used in X-Ray radiography or CT as both are nephrotoxic and neurotoxic. Because Gadolinium-based contrast agents pass the blood–brain barrier and of each bolus dose at least 1% of the Gadolinium is retained and assumed to be in its free toxic state; these products need further study. Anaphylactoid reactions are rare, occurring in approximately 0,03–0,1%.[5]

   Intravenous (IV) Gadolinium-enhanced MRI is typically used to help create a clearer picture of a brain tumor. In this examination, a patient first has a regular non-contrast MRI, and afterwards is given Gadolinium through an IV line. Then, a second MRI is done to get another series of pictures using the dye.

   Gadolinium has been found to remain in the body after multiple MRIs, even after a prolonged period of time. Although Gadolinium contrast agents have not been found to be harmful to the body, it is unknown whether these deposits can lead to adverse health

effects. The FDA has asked doctors to limit the use of Gadolinium contrast agents to times when necessary information is made available through its use.[6]

5.*Determine the tumor location*

Determine the location of the tumor, making sure the location is intra- or extra-axial. There are several imaging findings of extra-axial tumors, which are: (a) meniscus sign, (b) displacement of subarrachnoid vein inward, (c) buckling of the grey-white interface, (d) dura strecthed over the mass, (e) displacement of brain from the skull, (f) CSF cleft between brain and lesion **(Figure 2)**, (g) vessels interposed between brain and lesion, (h) cortex between mass and (edematous) white matter, and (i) dura (meninges) between (epidural) mass and brain. Signs and imaging findings that suggest or confirm the extra-axial location of the mass are summarized in **Table 1**.

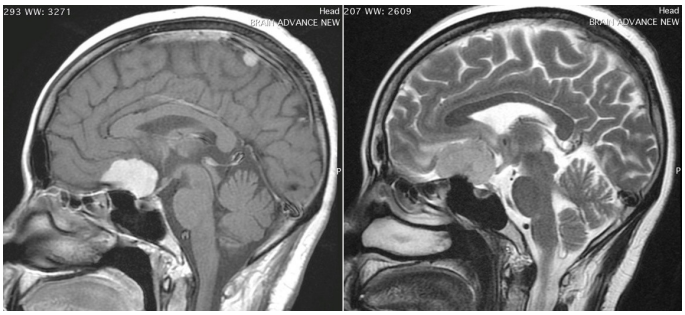

Figure 2. CSF cleft sign with vessels interposed between brain and lesion consistent with extra-axial mass. After contrast injection the mass enhanced strongly and homogenously. The mass pushes optic chiasm downward. Another extra axial small nodule was detected surrounding precentral gyrus.

Table 1. MR findings in extra-axial masses[7]

MR Findings in Extraaxial Mass	
Suggestive	**Definitive**
Peripheral, broadly based along the calvarium	CSF cleft between brain and lesion
Overlying bone changes	Vessels interposed between brain and lesion
Enhancement of adjacent meninges	Cortex between mass and (edematous) white matter
Displacement of brain from the skull	Dura (meninges) between (epidural) mass and brain

6.*Describe the extension of the tumor, the base of the tumor*

After knowing the exact location of the tumor, the next thing that needed to be done is describing the extension of the tumor, an example is given in **Figure 3.**

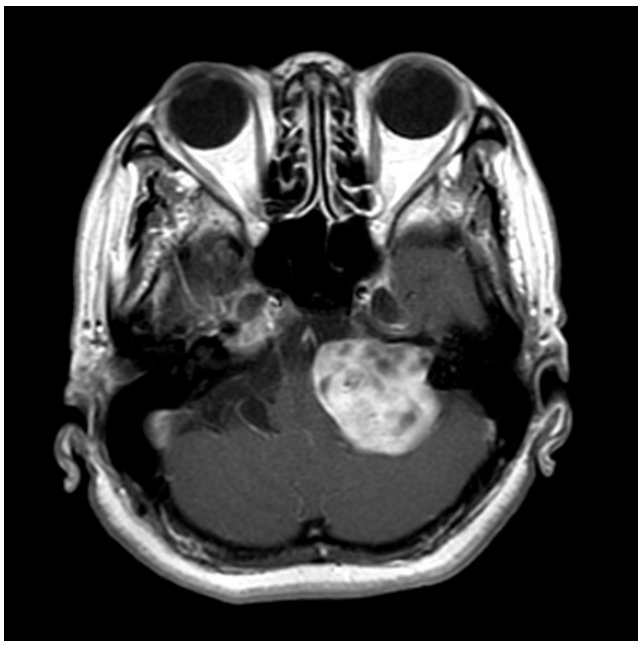

Figure 3. After contrast administration, tumor extension to right nerve canal can be seen.

7.*Determine the content of the tumor*

Some tumors may contain blood, calcification, necrosis or cystic areas. Blood content can be evaluated using T1W, T2W and GRE T2*. Blood inside a tumor has a specific sign, it may have different age, ie. acute, sub-acute, and chronic. Calcification is best demonstrated on CT. On MRI, calcification is best identified on susceptibility weighted images as areas of low signal intensity, however calcification may also be appreciated on T2W as areas of low intensity. Necrosis or cyst appears as low intensity on T1W and high intensity on T2W.

8.*Measure the size of tumor*

Tumor measurement can be done after contrast administration. The measurement is carried on axial, coronal, and sagittal slices.

9.*Associated bone changes in overlying calvarium*

Bony changes in overlying calvarium may appear as thickening of the bone with hypointense signal on T1W and T2W.

10.*Post-contrast administration*

After contrast administration, extra-axial tumor usually enhances strongly and homogenously, except in the necrotic areas. Dural tail sign can mimic other diseases, such as lymphoma. En-plaque meningiomas or intra-osseous meningiomas can also be differentiated after contrast-enhancement. Invasion to the nerve canal and the length of invasion are also possible to be evaluated after contrast administration **(Figure 4)**.

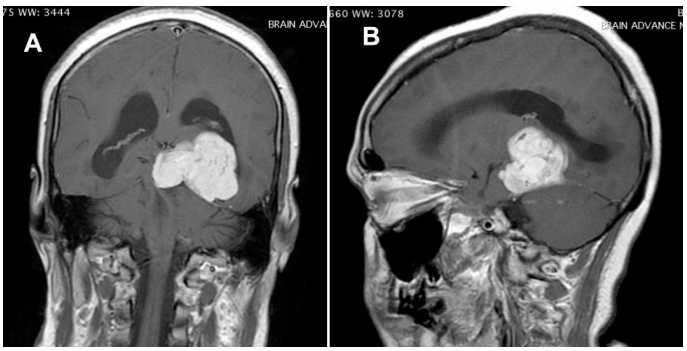

Figure 4. A. Coronal, and B. Sagittal T1W contrast-enhanced MRI. After contrast injection, it shows marked enhancement and the delineation of the mass is clear and sharp. Tumor attaches to cerebellar peduncle.

11.*Feeding artery using MRA/MRV*

MRV and MRA examinations are similar to an MRI, but they focus exclusively on the venous and arterial blood vessels in the head and neck area. A strong magnetic field is used to evaluate blood flow patterns and blood vessel abnormalities. An example of typical blood supply in meningiomas is summarized in **Table 2.**

In some cases, dye is injected into the bloodstream to improve the visibility of certain structures. A typical MRA examination and a typical MRV examination take approximately 10 minutes each to complete.[8]

12.*Advanced technique*

Advanced imaging methods, such as MR spectroscopy, perfusion MRI, functional MRI, diffusion-tensor imaging, and tractography, helps to develop a more accurate differential diagnosis and aid in planning tumor treatment. No single advanced technique is perfect, but different techniques typically complement one another.[8]

Table 2. Blood supply to meningioma[8]

Blood Supply to Meningioma	
Location of meningioma	**Commonly seen blood supply (origin of vessels)**
Convexity	Middle meningeal artery (ECA)
Sphenoid wing	Arteries of falx (Ophtalmic Branch) Middle meningeal artery (ECA)
Tentorium & CPA	Tentorial artery from meningohypophyseal artery (ICA)
Olfactory groove	Branch of ophtalmic Artery
Foramen magnum & clivus	Anterior meningeal artery (vertebral) Dorsal meningeal artery from meningohypophyseal artery (ICA

EXTRA-AXIAL TUMORS

WHO classifies tumors of the meninges into four groups, which are: (a) tumors of meningothelial cells (meningioma, angiomatous etc.), (b) mesenchymal, non-meningothelial tumors (osteosarcoma, osteoma lipoma etc.), (c) primary melanocytic lesions (Multiple Myeloma, diffuse melanocytosis, etc.), and (d) tumors of uncertain histiogenesis (hemangioblastoma).[9-11]

Tumors of the Meninges

Meningiomas have several subtypes which include atypical meningioma, malignant meningioma, mesenchymal meningeal tumors, hemangiopericytoma, meningiomatosis, and melanocytic lesions. The common location of meningiomas are : (a) parasagittal dura, (b) convexities, (c) sphenoid wing, (d) CPA cisterns, (e) olfactory groove, and (f) planum sphenoidale. Some of those locations can be observed from **Figure 5**.[12,13]

For evaluation of meningiomas, MR is superior to CT. Those superiorities are in detecting: (a) full extent of the tumor, (b) sinus invasion and/or thrombosis, (c) tumor vascularity, (d) intra-cranial edema, and (e) intra-osseous extension.[15]

Other extra-axial lesions which can be seen in daily practices are tumors of neurogenic origin such as schwannomas and neurofibromas, metastasis in the form of dural metastases or sub-arrachnoid seeding, choroid plexus masses (eg. choroid plexus papilloma, choroid plexus carcinoma, choroid plexus hemangioma, and choroid plexus xanthogranuloma), and non neoplastic masses (epidermoids, dermoid, teratoma, and lipoma).

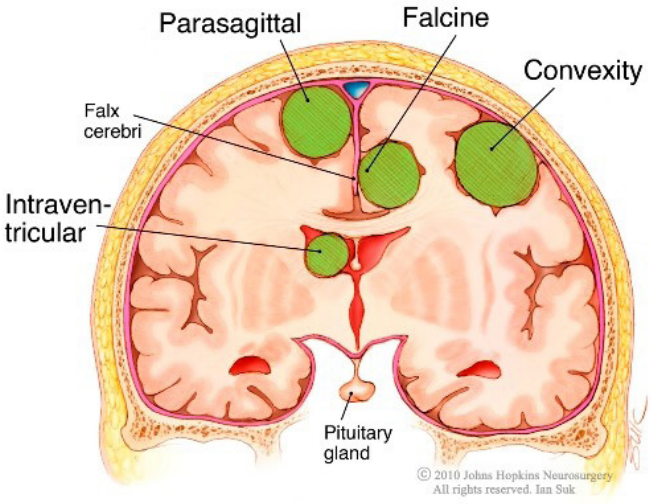

Figure 5. Location of meningioma[14]

CONCLUSION

Magnetic Resonance Imaging has a capability to delineate extra- or intra-axial tumor correctly. The extra- or intra-axial location of the tumor is critical for the disesase itself and patients, because it will affect treatment planning and prognosis. In order to characterize intra-cranial tissues or lesions, some specific sequences are needed. On of the most common intra-cranial tumor is meningioma, with incident rate of around 29%. In some situation, advance techniques can help to aid better and more accurate differential diagnosis of intra-cranial tumors.

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