CNS Imaging of Metastatic Melanoma

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Outline

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  - Epidemiology of CNS Metastases
- Imaging Modalities and Indications
  - Contrast-enhanced MRI
  - Melanin and Hemorrhage: The Diagnostic Dilemma
- Clinical Image Examples
- Patient Presentation: *A Tale of Two Metastases*
- Summary
Melanoma

- Melanoma is a cancer of melanocytes, or melanin producing cells derived from the neural crest.
- Projected lifetime risk of developing melanoma in the United States is 1/75.
- Melanoma has widespread metastatic potential.
- Preferential sites include:
  - Lymph nodes
  - Lung
  - Liver
  - **Brain**
  - Spleen
  - Kidneys
  - GI tract
  - Subcutaneous tissues

Malignant Melanoma

Epidemiology of CNS Metastatic Melanoma

- Melanoma metastasizes to the central nervous system more frequently than any other malignancy.
- Third most common cause of brain metastases in the US (after lung and breast.)
- Average time between first diagnosis of cutaneous melanoma and CNS metastasis is 45 months.
- 12-20% of patients present with their first metastasis to the CNS.
- Brain metastasis is found in 50% of patients with widely disseminated melanoma.
Treatment of CNS Metastatic Melanoma

- Palliative treatment includes
  - Surgical removal of lesions
  - Tumor debulking
  - Whole Brain Radiation Therapy
  - Biochemotherapy
  - Stereotactic Radiosurgery
Imaging of CNS Metastases

- **Indications**
  - Neurologic symptoms
  - R/O brain metastases prior to beginning some chemotherapy regimens (concern for brain toxicity.)

- $^{18}$FDG PET CT is not appropriate for detecting metastasis because of the physiologic uptake of $^{18}$FDG by the brain.

- **Contrast Enhanced MRI studies** recommended
  - Identify CNS metastasis missed by CT
  - Examine metastatic involvement of the spinal cord and lepto-meninges.
  - Melanoma has a unique tendency to hemorrhage.
    - MR can document presence of blood, approximate age of hemorrhage

- Three categories of signal intensity patterns seen on MRI for metastatic melanoma to the brain.
Three SI patterns of CNS melanoma metastasis

- **Melanotic Metastasis**
  - Signal on T1: increased signal intensity
  - Signal on T2: increased signal intensity
  - *10% of the tumor cells must have melanin in order for the MRI to show this signal pattern.*

- **Amelanotic Metastasis**
  - Signal on T1: decreased signal intensity
  - Signal on T2: decreased signal intensity

- **Metastasis w/ Hemorrhage**
  - Signal on T1: increased signal intensity
  - Signal on T2: decreased signal intensity
  - dependent on hemorrhagic progression

**Key**

- White square = increased signal intensity
- Black square = decreased signal intensity

*10% of the tumor cells must have melanin in order for the MRI to show this signal pattern.*
Metastasis with hemorrhage: The diagnostic dilemma

<table>
<thead>
<tr>
<th>STAGE</th>
<th>T1</th>
<th>T2</th>
<th>TIME FRAME</th>
<th>STATE OF HGB</th>
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<tbody>
<tr>
<td>Hyperacute</td>
<td></td>
<td></td>
<td>&lt; 12 hrs</td>
<td>IC oxy-HGB</td>
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<tr>
<td>Acute</td>
<td></td>
<td></td>
<td>1-3 d</td>
<td>IC deoxy-HGB</td>
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<tr>
<td>Early subacute</td>
<td></td>
<td></td>
<td>3-7 d</td>
<td>IC met-HGB</td>
</tr>
<tr>
<td>Late subacute</td>
<td></td>
<td></td>
<td>4-7 d to 1 mo</td>
<td>EC met-HGB</td>
</tr>
<tr>
<td>Chronic hemorrhage</td>
<td></td>
<td></td>
<td>1 mo to yrs</td>
<td>Hemosiderin</td>
</tr>
</tbody>
</table>

= iso to hypo-intense  = Hyper-intense  = Hypo-intense
Metastasis with Hemorrhage: The diagnostic dilemma

How do you differentiate melanin in a tumor from a simple hematoma?

- Heterogeneous SI patterns
  - (indicates multiple stages of hematoma aging.)
- Slower evolution of the hemorrhagic tumor
- Reduced, absent, or irregular hemosiderin-laden rim
- Persistent edema in the subacute and chronic stages.
  - (acute simple hematomas only have transient edema.)
- Administer contrast!
Let’s look at some images to illustrate these three categories of MR signal intensity patterns in CNS metastatic melanoma.
Companion Patient #1:
54 y.o. male w/ hx of acral lentiginous melanoma of the distal thumb

Melanotic melanoma appears as homogeneous, well-circumscribed, hyperintense nodules on T1 images.

Axial T1-weighted MR w/o contrast
Melanotic Pattern: T2 weighted image

- **Companion Patient #1**
  Same axial slice as previous T1-weighted image

- Nodules are hypointense on T2-weighted image, surrounded by areas of edema

*Axial T2-weighted MR w/o contrast*
Amelanotic pattern: T1 weighted images

Companion Patient #2:
40 year old male with metastatic melanoma

Axial T1-weighted MR w/o contrast
Axial T2-weighted MR w/o contrast

Amelanotic melanoma metastasis appears as well-circumscribed nodules with hypointense signal on T1, and hyperintense signal on T2.

http://radiographics.rsnaajnl.org/cgi/content/figsonly/21/3/625
A Tale of Two Metastases:
A Patient Presentation
CC: aphasia, R-sided blurry vision

- KR is a 35 year old male with a history of metastatic melanoma who presented in 2005 with two acute episodes of expressive aphasia and right-sided blurry vision.

- Difficulty saying the word “TAX” (said “PAX” w/ a “P”.)

- Patient saw a blurry blue line in his right visual field.

- Episodes lasted 10-15 minutes each, occurred three days apart. Symptoms spontaneously resolved.

- Neurologic ROS was o/w negative.

- Head MR w/ and w/o contrast was performed after second episode.
Patient KR: Metastasis #1
Left parietal metastasis with hemorrhage

Sagittal T1-weighted MR w/o contrast
Axial T1-weighted MR w/o contrast

Nodular area of heterogeneous hypo- and iso-intensity surrounded by a ring of well-circumscribed hyperintensity.
Patient KR: Metastasis #1

Rim enhancement is seen with administration of Gadolinium-DTAP. Focal specks of hyperintensity noted centrally.
Patient KR: Metastasis #1

- Fairly homogeneous, nodular central hypointense signal
- Focal specks of hyperintense signal centrally
- Surrounding area of homogeneous, hyperintense signal extending centrifugally that follows the shape of the gyri, not seen on T1!
Patient KR: Metastasis #1

- Hemorrhagic lesion with heterogeneous signal intensity.
- Identified three probable hemorrhagic stages
  - Acute (Predominant)
  - Early subacute vs. melanin
  - Late subacute vs. amelanotic
- Surrounded by persistent edema
- Diagnostically appears to be a hemorrhagic tumor.
- Given history and radiology findings, likely metastatic melanoma to the brain.
Two days later, Patient KR underwent a craniotomy for removal of the hemorrhagic left parietal metastasis.

A Head MR was obtained 24 hours s/p surgery.
Patient KR s/p surgery

*Axial T1-weighted MR with contrast*

*Coronal T1-weighted MR with contrast*

Note the resection site, the subdural hematoma along the left hemisphere, and the post-surgical effects on the skull.
Differential Diagnosis for Hemorrhage in the Brain

- Neoplasm
  - Primary
  - Metastasis
- AVM
- Hemorrhagic venous infarction
- Hypertensive vascular disease
- Stroke (Hemorrhagic)
- Trauma to head
- Aneurysm, Berry vs. Infectious
Differential Diagnosis for Hemorrhagic Metastasis in the Brain (M A T C H)

- Melanoma
- Naplastic lung carcinoma
- Thyroid carcinoma
- Horiocarcinoma
- Hypermephroma.
3 months later, during a follow-up head MR study on Patient KR...
Patient KR: Metastasis #2
Right parieto-occipital metastasis with hemorrhage

*Sagittal T1-weighted MR with contrast*  
*Sagittal T1-weighted MR with contrast*
Patient KR: Metastasis #2

Axial T2-weighted MR w/o contrast

Note the worsening edema, the decreasing central intensity, and the incomplete ring of hypointensity on the later image.
Metastasis #2

- Lesion w/ heterogeneous SI, mostly hyperintense on both T1 and T2, indicating a late subacute hemorrhage.

- Decreasing SI on T2 indicates that the hemorrhage is beginning to progress into a chronic stage.

- Incomplete ring of hemosiderin noted.

- Edema is significantly worsened on subsequent MR.

- Hemorrhage is evolving slowly.

- **Lesion represents hemorrhage into a tumor that is not resolving.**
Two months later, after experimental chemotherapy with oral temozolamide...
Patient KR: Metastasis #2 has decreased in size and the edema has resolved.
Summary

- Imaging of CNS metastatic melanoma is an important clinical problem.

- Contrast enhanced MRI is the preferred modality for imaging CNS metastatic melanoma.

- Recognize three different intensity patterns:
  - Melanotic
  - Amelanotic
  - Metastasis with hemorrhage

- Melanoma is common: you will take care of these patients, regardless of your field of medicine!
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  Viewed May 16, 2006.
Remember your ABCDs...

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<thead>
<tr>
<th>Normal Mole</th>
<th>Melanoma</th>
<th>Sign</th>
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<td>Asymmetry</td>
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<td></td>
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