Metastatic Melanoma: A Tour of Imaging Modalities

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Agenda

• Melanoma background
  – Statistics
  – Characteristics
  – Subtypes
  – Progression
  – Staging
  – Metastatic disease

• Index case

• Imaging modalities
  – Radiographs
  – CT
  – PET-CT
  – Ultrasound
  – MRI
Melanoma: Statistics in the US

- 6th most common cancer
- 76,100 invasive melanoma cases and 9710 deaths from melanoma estimated in 2014
- Incidence increasing faster than any other cancer
  - 3.1% per year from 1992 to 2004
  - 1 in 1500 lifetime risk for a person born in 1935
  - 1 in 58 lifetime risk in 2010 (1 in 39 in Caucasian men)
  - Partially due to increased screening rates and early detection

Melanoma: Characteristics

- Arise as superficial epidermal tumors of melanocytes
- Undergo a radial growth phase in the epidermis followed by an invasive vertical growth phase
- Metastasis can be rapidly aggressive
- Risk factors are numerous nevi (especially atypical nevi), excessive sun exposure, history of sunburns, and light skin

Benign nevi (top left), early melanoma (top right), and advanced melanoma (bottom).

Melanoma: The ABCDEs

A = Asymmetry
One half is unlike the other half.

B = Border
An irregular, scalloped or poorly defined border.

C = Color
Is varied from one area to another; has shades of tan, brown, or black, or is sometimes white, red, or blue.

D = Diameter
Melanomas are usually greater than 6 mm (the size of a pencil eraser) when diagnosed, but they can be smaller.

E = Evolving
A mole or skin lesion that looks different from the rest or is changing in size, shape or color.

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Melanoma: Subtypes

- Superficial spreading melanoma (75%)
  - Radial growth for a period of time before vertical growth
- Nodular melanoma (15-30%)
  - Vertical growth phase
- Lentigo maligna melanoma
- Acral lentiginous melanoma
Melanoma: Progression

Melanoma: Staging

• 2010 TNM staging system incorporates:
  – Thickness of primary tumor
  – Ulceration
  – Mitotic rate

• Stage I-IV based on TNM staging

• Stage III: Isolated metastases in lymph nodes, skin, or subcutaneous tissue

• Stage IV: Distant metastases


Melanoma: 15-year patient survival by thickness

Metastatic melanoma

- 4-10% of patients present with metastatic disease and an unknown primary skin lesion
- A great radiologic imitator of other diseases
- Widespread hematogenous dissemination results in metastatic disease to almost any site including rare sites of metastases, such as the heart and GI tract

Metastatic melanoma:
Most common sites

- Lymph nodes
- Lungs
- Liver
- Brain
- Heart
- Adrenal Glands
- GI tract
  - 1/3 of all GI metastases and most common cancer to metastasize to the small bowel, spleen, and gallbladder

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Index patient

- A 55-year-old man receives a wide local excision for a changing mole on his left chest
- Stage IIIC on diagnosis based on spread to >4 regional lymph nodes without distant metastases
- Lung nodule detected 2 years later
- Subsequent metastases to lungs, liver, brain, and bones over the next year
Our patient: Lung nodule on chest radiograph

No identifiable lung nodule

9 months later: Lung nodule evident prior to biopsy

From BIDMC PACS
Our patient’s lung nodule was diagnosed as metastatic melanoma on biopsy. It was first seen on CT as a growing lung nodule.
Our patient: Lung nodule concerning for metastasis on CT

Left upper lobe lung nodule

AXIAL C+ CT
Our patient: Lung nodule
3 months later on CT

Spiculated lung nodule

AXIAL C+ CT
Our patient: Lung mass
5 months later on CT

Growing lung mass

AXIAL C+ CT
Our patient: Lung nodules 8 months later on CT

Multiple lung nodules

AXIAL C+ CT
You have seen the growth of a metastatic lung nodule in our patient. At 8 months, anterior mediastinal lymphadenopathy was also present adjacent to this mass.
Our patient: Anterior mediastinal lymphadenopathy on CT

Lymphadenopathy AXIAL C+ CT
Increasing size of axillary lymphadenopathy in our patient over 2 months was also concerning for metastatic disease.
Our patient: Axillary lymphadenopathy on CT

Axillary lymph node (1.5 x 1.4 cm)

Axillary lymph node (2.2 x 1.7 cm) 2 months later
You have seen chest radiographs and CT scans of metastatic melanoma in the lungs and lymph nodes of our patient. Now we will continue to discuss other imaging modalities of metastatic melanoma.
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Overview of PET-CT

• A PET scan indicates areas of high glucose uptake. It is fused with a CT scan in a PET-CT to correlate physiologic regions of increased glucose uptake with anatomic lesions.
• “Hot spots” are seen in melanoma and other neoplastic tissues due to greater metabolic demand.
• False positives occur due to inflammation or attenuation artifact.
• Normal areas of uptake include the brain, urinary system, bowel, skeletal muscle, brown fat, and myocardium.
• PET-CT is indicated for staging and detection of recurrent melanoma, especially when there is metastatic disease.

Our patient: Hot spots on PET scan

A PET scan shows hot spots of abnormal glucose uptake in the **left lung** and **right axilla** concerning for metastatic melanoma. Uptake in brain, kidneys, bladder, and other less dense areas is normal.
Our patient: Hot spots on PET-CT

Lung nodule

From BIDMC PACS
Our patient also had metastatic disease in the liver. Liver metastases can be visualized on various imaging modalities. We will take a look at metastatic melanoma in the liver on CT and ultrasound.
Our patient: Liver metastases on axial C+ CT

Benign liver cyst: Non-enhancing, homogeneous hypoattenuation, thin imperceptible wall

Liver lesion 4 months later concerning for metastasis: Poorly defined borders and heterogeneous density

Multiple metastatic liver lesions 10 months later
Companion patient #1: Liver metastases on ultrasound

Numerous hyperechoic liver lesions represent metastatic melanoma. A central hypoechoic region represents necrosis.

A hyperechoic lesion near the liver surface represents metastatic melanoma.

You have seen metastatic melanoma in the lungs, lymph nodes, and liver of our patient. It can also metastasize to many other areas in the abdomen seen in a companion patient.
Companion patient #2:
Subcutaneous metastases on CT

Subcutaneous nodules
AXIAL C+ CT
Companion patient #2: Adrenal gland metastasis on CT

Adrenal gland mass (SAGITTAL C+ CT)
Companion patient #2: Abdominal metastases on CT

This patient had diffuse metastatic melanoma in the abdomen culminating in a large abdominal mass with unknown origin.

(CORONAL C+ CT)
Companion patient #2: Hot spots on PET scan

A PET scan shows diffuse hot spots of abnormal glucose uptake throughout the body with a large mass in the LUQ of the abdomen. Brain, kidney, and bladder uptake is normal.
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You have seen metastatic melanoma in the lungs, lymph nodes, and liver of our patient. He also had metastatic disease in the brain, which is best visualized on MR imaging.
Overview of T1 MR head

• T1 is the anatomic sequence
  – White matter is white, gray matter is gray
  – Fat, hemorrhage, gadolinium, and melanin are hyperintense (bright)
  – Fluid is hypointense (dark)
Overview of T2 MR head

- T2 is the fluid sensitive sequence
  - White matter is gray, gray matter is white
  - Fat and fluid are hyperintense
- T2 flair: CSF suppressed
- T2 GRE: Hemorrhage is hypointense
- T2 STIR: Fat suppressed
- T2 weighted trace: Areas of restricted diffusion are hyperintense on DWI and hypointense on ADC
MR head: Metastatic disease

- Most metastatic disease is not well-defined on T1, but is evident with gadolinium contrast due to associated edema.
- Metastatic melanoma is uniquely hyperintense on T1, but may be isointense on T1 with low melanin content.
- Hemorrhagic metastatic lesions are also hyperintense on T1.
- T2 GRE detects hemorrhagic metastases, which more frequently occur with melanoma, choriocarcinoma, renal cell carcinoma, and thyroid cancer.

Our patient: Brain masses on T1 MR

Hyperintense lesions on T1 without contrast suggest metastatic melanoma.
(AXIAL T1 C- MR)

3 of many additional hyperintense lesions on T1 with contrast suggest edema associated with metastatic melanoma.
(AXIAL T1 C+ MR)
Our patient: Brain masses on T2 MR

2 of many hypointense lesions suggest hemorrhage associated with metastatic melanoma. (AXIAL T2 GRE MR)

3 of many hyperintense lesions indicate edema from metastatic melanoma. (AXIAL T2 FLAIR MR)
You just saw metastatic melanoma in the brain of our patient on T1 and T2 MR imaging. He also had metastatic disease in the bones, including the sternum and spine.
Our patient:
Sternum metastasis on CT

There is a lytic lesion in the sternum concerning for metastatic melanoma. There are also several lytic lesions in the spine.
(SAGITTAL C- CT)
Our patient:
Spine metastases on MR

2 of many lytic lesions in the cervical and thoracic spine are heterogeneously enhancing.

(SAGITTAL T1 C+ MR)
Thoracic and lumbar spine on T2 STIR

The halo sign and 2 of many areas of diffuse hyperintensity on T2 strongly indicate metastatic disease. These findings are more easily detected on T2 STIR due to fat suppression in normal bone marrow.

(SAGITTAL T2 STIR MR)
You have seen metastatic melanoma in the lungs, lymph nodes, liver, brain, and bones of our patient in various imaging modalities. A discussion of his diagnosis, treatment plan, prognosis, and outcome follows.
Our Patient: Diagnosis

• A wide local excision of an ulcerated changing mole on the left chest of our patient revealed a thick invasive melanoma with a nodular vertical growth phase

• The lesion was stage IIIC melanoma at diagnosis due to involvement of >4 regional lymph nodes (left axillary lymph nodes)
Our Patient: Treatment Plan

- Wide local excision of primary lesion
- One year of adjuvant interferon therapy
- After metastatic disease detected:
  - High dose IL-2 systemic therapy considered
  - Vemurafenib therapy received
Our Patient: Prognosis

- Stage IIIC melanoma has a 5-year survival rate of around 40% and a 10-year survival rate of around 24%.

Our Patient: Outcome

• Metastatic lung nodule detected 2 years after diagnosis
• Widespread metastases to liver, brain, and bones within the following year
• Our patient passed away 3 years after diagnosis while in palliative care due to extensive metastatic disease
Summary

- Melanoma is a cancer of melanocytes in the skin that can rapidly progress to widespread metastases.
- Common areas of melanoma metastasis are lymph nodes, lungs, liver, brain, heart, adrenal glands, and GI tract.
- Our index patient showed lymph node metastases on diagnosis, lung metastasis 2 years later, and widespread metastatic disease to lungs, liver, brain, and bones within the following year.
- Various imaging modalities can detect metastatic melanoma lesions. You saw metastatic melanoma lesions on radiographs (chest), CT (chest and abdomen), PET/CT (total body), ultrasound (liver), and MRI (head and spine).
References


References

• Rigel DS, Russak J, Friedman R. The evolution of melanoma diagnosis: 25 years beyond the ABCDs. CA Cancer J Clin 2010; 60:301.
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