The Radiologic Exploration of a Carotid Body Tumor

Molly Kantor, Harvard Medical School Year III
Gillian Lieberman, MD

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Agenda

• Patient History and Physical Exam Findings
• Differential Diagnosis of a Neck Mass
• Anatomy Review
• Patient Imaging and Refining the Differential
• Overview of Carotid Body Tumors
• Menu of Tests to image Carotid Body Tumors
• Our Patient’s Interventional Radiology Images
Our Patient’s History and Physical exam
Our Patient: History

• 29 year old nurse
• Incidental finding on neck MRI at OSH for whiplash s/p motor vehicle accident
• Aware of a lump in her left neck since age 17, believed to be a lymph node but not evaluated
• Asymptomatic
  – Denies pain, dysphagia, odynophagia, hoarseness, change in voice
• PMH & PSH: Cesarean section, Hashimoto thyroiditis, nasal septoplasty
• SHx: denies smoking or drinking
Our Patient: Physical Exam

• Exam:
  – Firm, nontender soft-tissue mass in the left neck
    • Moves side-to-side but not up and down
    • Close in proximity to carotid pulsation
  – No palpable lymphadenopathy
  – No masses on the right
  – No bruit auscultated
  – No thyroid nodules palpated
  – Normal laryngoscopic examination
Differential Diagnosis
Differential Diagnosis of Neck Mass

• Congenital
  – Usually present at birth but may present at any age

• Inflammatory
  – Typically viral and last < 6 weeks

• Neoplastic
  – Both benign and malignant
  – In an adult, suspect malignancy first
DDx: Congenital

• Branchial cleft cyst
  – First, second, or third
• Thyroglossal duct cyst
• Dermoid cyst
• Thymic cyst
• Vascular anomalies
  – hemangiomas, malformations, lymphatic malformations
• Ranula
• Teratoma
DDx: Inflammatory

- Reactive lymphadenopathy (infectious):
  - Viral – most common
  - Bacterial – including unusual bacteria such as tularemia, brucellosis, toxoplasmosis
  - HIV-associated

- Non-infectious lymphadenopathy:
  - Including sarcoidosis, Castleman disease, Rosai-Dorfman disease, Kawasaki disease (children < 5)
DDx: Neoplastic

• Malignant:
  – Carcinomas of the tonsil, tongue base, thyroid
  – Lymphoma
  – Sarcoma
  – Metastatic disease: squamous cell carcinoma of the aerodigestive tract, cutaneous malignancies

• Usually benign
  – Salivary gland neoplasm
  – Paraganglioma

• Benign
  – Schwannoma
  – Lipoma
  – Benign thyroid masses – cysts, nodules, adenomas
  – Benign skin cysts, e.g. epidermoid inclusion cyst
Anatomy: Triangles of the Neck

UpToDate: Anatomical regions of the neck
http://www.uptodate.com/online/content/image.do?imageKey=PC%2F21883
Anatomy: Vasculature of the Neck

Adapted from: http://accweb.itr.maryville.edu/myu/Bio301Summer/301on9.html
Anatomy: Carotid Bifurcation

Netter’s Clinical Anatomy, 2nd ed.
Figure 8-58 Major Arteries of the Head and Neck
Anatomy: External Carotid Artery

Netter’s Clinical Anatomy, 2nd ed.
Figure 8-48 External Carotid Artery and Its Branches
Our Patient’s Images
Our Patient’s Carotid Body Tumor on MRI

Coronal MRI, T1, post-contrast, subtraction image
Our Patient’s Carotid Body Tumor on MRI: Close Up

Large (2.5cm x 2.0 cm x 3.6 cm), heterogeneous, enhancing mass at the level of the carotid bifurcation

*PACS, BIDMC*  
Coronal MRI, T1, post-contrast, subtraction image
Our Patient’s Carotid Body Tumor on MRI: Arterial Structures

R and L internal carotid artery

Mass

L common carotid artery

R external carotid artery

R common carotid artery

Coronal MRI, T1, post-contrast, subtraction image
Our Patient’s Carotid Body Tumor on MRI: Venous Structures

Mass

R internal jugular vein

R external jugular vein

R subclavian vein

L internal jugular vein

L external jugular vein

L subclavian vein

Coronal MRI, T1, post-contrast, subtraction image
Our Patient’s Carotid Body Tumor on MRI: Glandular Structures
Our Patient’s Carotid Body Tumor on MRI: Splaying Carotids

The mass splays the external and internal carotid arteries

Axial MRI, T1, without contrast
Our Patient’s Carotid Body Tumor on MRI: Splaying Carotids (arteries labeled)

Comparison of the right and left shows the mass splaying the left external and internal carotids

Axial MRI, T1, without contrast
Our Patient’s Carotid Body Tumor on MRI: Splaying Carotids (labeled)

Axial MRI, T1, without contrast
Our Patient’s Carotid Body Tumor on MRI: Common Carotid level

Axial MRI, T1, without contrast
Our Patient’s Carotid Body Tumor on MRI: Common Carotid level (labeled)

- Pharynx
- R submandibular gland
- R common carotid artery
- Vertebral body
- L submandibular gland
- L common carotid artery
- Mass
- Sternocleidomastoid muscle
- Spinal cord

Axial MRI, T1, without contrast
Our Patient’s Carotid Body Tumor on MRI: Comparison of T1 and T2

The mass is brighter on T2 than T1, and enhances, consistent with a tumor

**PACS, BIDMC**

Axial MRI, T1 and T2 images, without contrast
Refining the Differential based on the patient’s imaging and H&P
DDx for Our Patient’s tumor based on MRI

• **Soft tissue** mass, not cystic or made of fat
  – Rule out branchial cleft cyst, thyroglossal duct cyst, dermoid cyst, thymic cyst, thyroid cyst, teratoma, lipoma, skin lesions

• The mass **enhanced**
  – Indicates hypervascular
  – Rules out cysts (above), ranula, teratoma, lymphadenopathy

• **Located at carotid bifurcation and splays the carotids**
  – Rule out salivary gland tumor, benign thyroid mass, Schwannoma, tonsilar tumor, aerodigestive tract tumor, tongue tumor, skin lesions
  – Great location for a **paraganglioma**
... combined with the H & P

- Mass has been present for at least 12 years
  - Not aggressive, so unlikely to be metastatic disease (SCC of aerodigestive tract, skin cancer, thyroid) or lymphoma
- Moves side to side but not up and down

This is a Paraganglioma!
Overview of Carotid Body Tumors
Carotid Body Tumors

• Paragangliomas are rare tumors of neural crest cells associated with extraadrenal autonomic ganglia
  – Carotid body tumors are the most common type

• Tumor characteristics
  – Rarely (1-3%) functioning (secrete catecholamines)
  – Grow indolently, ~1mm/year
  – Rarely metastatic
  – 10%-50% have a family history
    • When hereditary, often present earlier (< 35) and in multiple

• Diagnosis: H&P + imaging!
  – Often pulsatile, often a bruit can be heard, and classically mobile in a side to side but not vertical direction

• Treatment options:
  – Surgical excision (often with pre-op embolization of blood supply)
  – Radiation
Menu of Tests
Menu of Tests: Carotid Body Tumor

- CT
- MRI
- Doppler Ultrasound
- Angiography
- Nuclear medicine: Octreotide Scintigraphy
Menu of Tests: CT

- **CT**
  - Homogenous mass with intense enhancement with IV contrast
  - Typically displaces the carotid bifurcation

- **MRI**

- **Doppler Ultrasound**

- **Angiography**

- **Nuclear medicine: Octreotide Scintigraphy**
Menu of Tests: MRI

- CT
- MRI
  - Often is intermediate signal of T2 and classically “salt and pepper” on T2
  - Smooth contours and located at the carotid bifurcation
  - Assess size and extent of tumor, course of vessels, and relationship to surrounding structures (better than CT)
- Doppler Ultrasound
- Angiography
- Nuclear medicine: Octreotide Scintigraphy
Menu of Tests: Doppler Ultrasound

- CT
- MRI
- Doppler Ultrasound
  - Used to visualize the tumor and the mass effect on the surrounding structures
  - Often used in conjunction with CT or MRI
- Angiography
- Nuclear medicine: Octreotide Scintigraphy
Menu of Tests: Angiography

• CT
• MRI
• Doppler Ultrasound
• Angiography
  – Direct visualization of the vessels and tumor blood supply
  – Can be both therapeutic and help in surgical planning (e.g. adequacy of intracranial circulation if sacrifice of the internal carotid is necessary)
• Nuclear medicine: Octreotide Scintigraphy
Menu of Tests: Nuclear Medicine

- CT
- MRI
- Doppler Ultrasound
- Angiography

- **Nuclear medicine: Octreotide Scintigraphy**
  - Neuroendocrine tumors have a high density of somatostatin type 2 receptors
  - Can be used to preoperatively identify unexpected sites of disease
Carotid Body Tumor Menu of Tests: Summary

• **CT**
  – Homogenous mass with intense enhancement with IV contrast
  – Typically displaces the carotid bifurcation

• **MRI**
  – Often is intermediate signal of T2 and classically “salt and pepper” on T2
  – Smooth contours and located at the carotid bifurcation
  – Assess size and extent of tumor, course of vessels, and relationship to surrounding structures (better than CT)

• **Doppler Ultrasound**
  – Used to visualize the tumor and the mass effect on the surrounding structures
  – Often used in conjunction with CT or MRI

• **Angiography**
  – Direct visualization of the vessels and tumor blood supply
  – Can be both therapeutic and help in surgical planning (e.g. adequacy of intracranial circulation if sacrifice of the internal carotid is necessary)

• **Nuclear medicine: Octreotide Scintigraphy**
  – Neuroendocrine tumors have a high density of somatostatin type 2 receptors
  – Can be used to preoperatively identify unexpected sites of disease
Comparison Patient 1: Carotid Body Tumor on CT

A mass at the carotid bifurcation on the left

R external carotid artery

R internal carotid artery

R vertebral artery

L external carotid artery

L internal carotid artery

Mass

Axial CT with contrast
Comparison Patient 1: Carotid Body Tumor on MRI

As with our previous patient, the mass is bright on T2 and splays the carotids.

Axial MRI, T1 and T2 (fat sat), without contrast
Comparison Patient 2: Carotid Body Tumor on Ultrasound

Densely echogenic mass in the left neck with some areas of altered echogenecity

Comparison Patient 3: Carotid Body Tumor on Nuclear Medicine

Lesion

111-indium labeled octreotide scintigraphy

Our Patient’s Interventional Radiology Images
The Plan for H.K.’s Tumor

• **Embolization** followed by **surgical excision** the next day
  – Embolization (by interventional radiology) to cut off the tumor’s blood supply
  – Surgery (by an ENT and a vascular surgeon) because there is a low chance (3%) of being malignant, the tumor is likely to grow over time and easier to remove when smaller
Our Patient’s Carotid Body Tumor on Angiogram

Vascular blush seen at the carotid bifurcation, and displacement of the internal and external carotid arteries is also evident.
Our Patient’s Angiogram: Anatomy (posterior view)

- Ascending pharyngeal artery
- Internal carotid artery
- External carotid artery
- Superior thyroid artery
- Common carotid artery

Angiogram, left common carotid artery
Our Patient’s Angiogram: Anatomy (lateral view)

- Superficial temporal artery
- Maxillary artery
- Facial artery
- Lingual artery
- Superior thyroid artery

Angiogram, left external carotid artery

PACS, BIDMC
Injecting contrast through a microcatheter in a branch of the ascending pharyngeal artery causes the tumor to blush.
Our Patient’s Angiogram: Embolization

Two of three feeding branches of the ascending pharyngeal artery were embolized with Embospheres and one coil

Angiogram, left ascending pharyngeal artery
Our Patient’s Angiogram: Pre- and Post- Embolization

Tumor blusses only from inferior branches, not from ascending pharyngeal artery

Angiogram, left common carotid artery
Our Patient: Further Follow-Up

- H.K. had an successful surgery with preservation of both the internal and external carotid arteries and a post-operative course complicated only by minor nerve weakness.
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References


