Emerging role of OctreoScan and Ga-68 Dotatate (NETSPOT) in recurrent meningioma diagnosis and management
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The authors have no disclosures.
# Meningioma Facts

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<th>+37,000 cases per year</th>
<th>24-32% recur within 15 years of surgical resection</th>
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<td>39% of primary brain tumors</td>
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<td>Over 80% are WHO Grade I</td>
<td>95% of recurrences are in the same location</td>
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<td>Typically affects adults &gt; 65</td>
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<td>67% 5-year survival rate</td>
<td>Surveillance performed with neuroimaging</td>
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Mechanism of Action

Somatostatin analog
- $^{111}$In-labeled octreotide/pentetreotide is a radiotracer with high affinity for somatostatin receptor 2.
- Meningiomas express somatostatin receptors (SSTR), though to a lesser extent than adrenal medullary tumors or abdominal neuroendocrine tumors. Therefore, they uptake octreotide.

Interpretation
- Normal physiologic uptake in the pituitary, thyroid, spleen (critical organ), liver, and renal parenchyma.
- Activity in gallbladder, bowel, renal collecting systems, ureters, and urinary bladder due to clearance
- Bowel activity usually minimal at 4 hours

Protocol

Patient preparation
- Clear liquid diet for 24 hours (more important for imaging of abdominal tumors)

Exam protocol
- Up to 6 mCi of In-111 pentetreotide injected intravenously
- Planar images using a gamma camera at 24 hours, optionally at 4 and 48 hours. SPECT/CT as needed.
Recurrence at margin of total resection cavity

79-year-old female with history of atypical meningioma, partially resected and treated with gamma knife SRS, with continued growth.

(A) Recurrent mass with large mass effect and edema.  
(B-C) Postoperative MR with small linear and nodular foci of enhancement along the inferior margin and anterior-superior aspect of the resection cavity.  
(D) No corresponding finding on perfusion MR.  
(E-G) Increased uptake on planar OctreoScan in the left frontal region suggestive of recurrence, corresponding to increased size of the nodular enhancement.  
(H) Further increased uptake on follow-up repeat OctreoScan fused MRI confirmatory for slowly growing residual meningioma.
Residual disease after partial resection

Patient with left petroclival meningioma, partially resected in 2015. Complicated by pontine stroke and multiple cranial nerve palsy, worsening right hemibody weakness and foot drop, leading to multiple falls.

Axial T1-weighted images with contrast (A-B) show growth of left petroclival mass over 2-year interval. (C) shows chronic T2 signal changes in the pons. (D) axial time-of-flight image showing encasement of ICAs and basilar artery.

(E) Fused OctreoScan SPECT/T1 post-contrast image showing avid uptake in the left petroclival mass, compatible with recurrent meningioma.
OctreoScan

Summary

Advantages
• Depends on Mo/Tc generator which is widely available to all departments
• Whole body imaging

Disadvantages
• False-negatives can occur due to variable receptor expression, or small tumor size causing SSTR density below the resolution of OctreoScan.
• For OctreoScan, limit of resolution is diameter <2.7 cm or volume <10 mL.
• Patients typically have to be scanned twice with an intensive preparation process.
Netspot Protocol and Mechanism of Action

Mechanism of Action

Molecular imaging
• Netspot is a kit approved for use by the FDA. Allows usage of this tracer by departments that don’t have utilizes Ga68-labeled

Interpretation
• Similar normal biodistribution to OctreoScan, with two additions:
  • Normal uptake in the pituitary gland.
  • Normal uptake in the adrenal glands.
• Important to compare to FDG-PET, CT, and all priors including remote studies.
• Need to pay attention to masses that are not avid on Netspot, as these may represent additional malignancy or poorly differentiated NET, which lose SSTR expression.

Protocol

Patient preparation
• Adequate hydration and urination is important to minimize radiation dose.
• If on therapy, imaging should be obtained prior to administration or after withdrawal of long-acting somatostatin analogs.
• Ga 68-dotatate administered IV.

Exam protocol
• Images can be acquired 40-90 minutes after administration of IV gallium 68-dotatate.
• Whole body PET images from skull to mid-thigh.
Small local recurrence after total resection

(A-B) Young female with incidentally found right sphenoid wing meningioma after MVC. Showed slow growth on surveillance MRI. (C) Underwent biopsy and total resection. (C-D) Small approx. 2 x 1 cm enhancing tissue along the lateral aspect of the right cavernous sinus/sphenoid bone. Stable on follow-up MRI. (E) Confirmed avidity along right cavernous sinus on Ga68-PET. Note physiologic uptake in the suprasellar region.
Small recurrence after total resection

(A-C). Middle-aged male with history of slowly growing meningioma underlying the right inferior frontal gyrus. (D-E) Underwent resection with thin nodular enhancement along the inferior margin of the resection cavity, initially indeterminate scar vs. residual meningioma. (F) Follow-up surveillance MRI showed increased mass-like enhancement measuring approximately 1 cm in the resection bed, suspicious for recurrence. (G) Confirmed with Netspot fused PET/CT showing uptake in the resection bed.

* Note the usefulness of Netspot in these cases confirming small recurrence 1 cm in size. These would be below the resolution of planar or fused SPECT/CT OctreoScan.
Confirmation of avid Dotatate uptake to guide chemotherapy initiation

Young female who initially presented with right eye proptosis. Underwent vision-sparing sparing subtotal resection of large skull base meningioma involving greater and lesser sphenoid wings, middle and anterior fossa. (C-D) Postoperative appearance showing reduced bulk of tumor, centered on right cavernous sinus with extension into the right orbit, skull base foramina, and sella. (E) Netspot PET/CT showing avid Ga-68 uptake. (F-H) Stable disease on follow-up MRI after initiation of Everolimus and Octreotide per Phase II CEVOREM trial.
Netspot compared to OctreoScan

Advantages
• Higher sensitivity and spatial resolution, improved image quantification.
• More convenient for patients (scan completed in 2 hours).
• Lower radiation dose on average compared to OctreoScan.
• In several tumors, head-to-head comparisons of Netspot to OctreoScan showed that additional imaging with Netspot changed treatment management in a significant fraction of patients.

Disadvantages
• Using Gallium-68 based radionuclides means a 68Ge/68Ga generator is required. Challenging and requires dedicated radiopharmacy staff, unlike 99Mo/99mTc. Limits to big departments.
• This is mitigated by kit-based labeling approaches that have received regulatory approval in the EU and USA.
• High positron energy and range may compromise spatial resolution.
Future Directions

**Theranostics – Lutathera**

Lutathera is a beta particle-emitting somatostatin analog recently FDA approved for therapy for gastroenteropancreatic NET.

Phase II Trial for inoperable meningiomas that are recurrent after external beam radiation.

- Netspot IV and undergo PET/MRI before cycles 1-4. Then Lu-177 dotatate over 30-40 minutes. Cycles repeat every 8 weeks up to 6 months in the absence of disease progression or unacceptable toxicity.
- OctreoScan or Netspot confirm the presence of somatostatin receptors within the tumor so that Lutathera may be efficacious.

**Lutathera treatment role in disease in anaplastic (WHO grade III) meningioma**

(A) OctreoScan performed showing SSTR expression in WHO grade III meningioma.

(B-D) Progression of disease despite treatment with systemic therapies (Everolimus and Octreotide, and Bevacizumab and Hydroxyurea).

(E) Stability of disease after four cycles of Lutathera.

After cessation of Lutathera, there was re-progression of disease.
Summary

Differentiate meningioma from other dural pathology when combined with MR. NetSpot has high sensitivity for small tumor recurrence when MRI and clinical findings are equivocal.

Somatostatin receptor scintigraphy (SRS)

Can be used both for initial diagnosis and surveillance. Prove SSTR activity to qualify eligibility for theranostics for unresectable tumors.

https://uihc.org/health-topics/what-theranostics