IAEA PET/CT Teaching Library

Medullary thyroid cancer with metastases

Comparison of FDG-PET with Ga-68 DOTATATE PET
Clinical Summary

61 year old Vietnamese male

Presented with metastatic tumour of unknown primary.

Liver and renal biopsies showed metastatic neuroendocrine tumour.

Elevated CEA: 32.9 ug/L (normal <5.3)

Referred for FDG PET/CT to localise primary tumour and determine extent of disease.
FDG PET/CT findings

FDG study showed an intensely hypermetabolic nodule in the left thyroid lobe 3.7 x 2.5 cm in size with $SUV_{\text{max}}$ 17.7
FDG PET/CT findings

FDG PET/CT whole body survey revealed widespread hypermetabolic lesions involving the lung, mediastinum, hilar nodes, liver, kidneys, supradiaphragmatic and abdominal lymph nodes, peritoneum and skeleton.
Medullary thyroid carcinoma was suspected

Thyroid FNA cytology:
Atypical cells suspicious for medullary thyroid carcinoma

Serum calcitonin elevated: 826.7 ng/L (normal <10)

Histopathology of liver and renal biopsies:
Carcinoma with neuroendocrine features
Comparison between FDG PET/CT and Ga-68 DOTATATE PET/CT revealed a combination of concordant and discordant metastatic foci.

**Concordant lesions:** thyroid, lung, mediastinal nodes and bones

**Discordant lesions:** liver, kidney and peritoneal nodules
Concordant lesions: Thyroid
Concordant lesions: Ribs and Lung
Concordant lesions: Ribs and Scapula

FDG PET/CT

Ga-68 DOTATATE PET/CT

http://humanhealth.iaea.org
Concordant lesions: Left ilium

FDG PET/CT

Ga-68 DOTATATE PET/CT
Discordant lesions: Liver

FDG PET/CT

Ga-68 DOTATATE PET/CT
Discordant lesions: Left kidney and abdominal nodes

FDG PET/CT

Ga-68 DOTATATE PET/CT
Discordant lesions: Peritoneal nodules

FDG PET/CT

Ga-68 DOTATATE PET/CT
Patient follow-up

The patient returned to Vietnam after the Ga-68 DOTATATE PET/CT and did not have further treatment or follow-up at Singapore General Hospital.
Discussion

Ga-68 DOTATATE PET/CT for medullary thyroid carcinoma and implications of discordant nodules between FDG and Ga-68 DOTATATE

Comparison of $^{68}$Ga-DOTATATE and $^{18}$F-fluorodeoxyglucose PET/CT in the detection of recurrent medullary thyroid carcinoma

Brendon G. Conry • Nikolaos D. Papathanasiou • Vineet Prakash • Irfan Kayani • Martyn Caplin • Shahid Mahmood • Jamshed B. Bomanji
Discussion

Ga-68 DOTATATE PET/CT for medullary thyroid carcinoma and implications of discordant nodules between FDG and Ga-68 DOTATATE

• Brendon et al. examined 18 patients and reported a sensitivity of 72.2% (CI 46.4-89.3%) for Ga-68 DOTATATE PET/CT versus 77.8% (CI 51.9-92.6%) for FDG PET/CT. The difference was not statistically significant (McNemar’s test, p = 0.056).

• 9 out of 18 patients (50%) were noted to have a combination of concordant and discordant lesions.

• This may be due to heterogeneous somatostatin receptor expression in the metastatic lesions or tumor dedifferentiation.

• The authors recommend that Ga-68 DOTATATE PET/CT for medullary thyroid carcinoma may be useful as:
  – A complementary modality in combination with standard imaging
  – To identify suitable candidates for targeted radionuclide therapy
Discussion

Correlation of tracer uptake with tumour grade

There is higher uptake of $^{68}$Ga-DOTATATE in low-grade NET as compared to high-grade NET.

Conversely, there is higher uptake of $^{18}$F-FDG in high-grade NET as compared to low-grade NET.

Discussion

Correlation of tracer uptake with tumour grade

<table>
<thead>
<tr>
<th>Numbers of Patients Showing Predominant Uptake of $^{68}$Ga-DOTATATE or $^{18}$F-FDG According to Tumor Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predominant uptake of $^{68}$Ga-DOTATATE</td>
</tr>
<tr>
<td>------------------------------------------</td>
</tr>
<tr>
<td>High/intermediate-grade NET</td>
</tr>
<tr>
<td>Low-grade NET</td>
</tr>
<tr>
<td>Total</td>
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</table>

Two-tailed $P < .0001$. Fisher exact T-test.

NET indicates neuroendocrine tumors; $^{68}$Ga-DOTATATE, $^{68}$Ga-DOTA-[SCAP]D[R]Phe$^1$,Tyr$^3$-octreotate; $^{18}$F-FDG, $^{18}$F-Fluorodeoxyglucose.

Discussion

Correlation of tracer uptake with tumour grade and Ki67 index

<table>
<thead>
<tr>
<th>SUVmax of $^{68}$Ga-DOTATATE and $^{18}$F-FDG According to Tumor Grade</th>
<th>$^{68}$Ga-DOTATATE</th>
<th>$^{18}$F-FDG</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>All NET</td>
<td>16.9 (1.6–50)</td>
<td>4.2 (1.4–16.4)</td>
<td>.005</td>
</tr>
<tr>
<td>Low-grade NET Ki67 index ≤2%</td>
<td>29 (3.3–45)</td>
<td>2.9 (1.5–12)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Intermediate NET Ki67 index 3%–20%</td>
<td>15.5 (1.8–50)</td>
<td>10.5 (2.0–13.9)</td>
<td>NS</td>
</tr>
<tr>
<td>High-grade NET Ki67 index &gt;20%</td>
<td>4.4 (1.6–8.9)</td>
<td>11.7 (4.1–16.4)</td>
<td>.03</td>
</tr>
</tbody>
</table>

SUVmax is the median SUVmax with range in parentheses.
SUVmax indicates maximum standardized uptake value; NET, neuroendocrine tumor; $^{68}$Ga-DOTATATE, $^{68}$Ga-DOTA-[SCAP]D[R]Phe$^1$,Tyr$^3$-octreotate; $^{18}$F-FDG, $^{18}$F-Fluorodeoxyglucose.

Teaching points

• For medullary thyroid carcinoma $^{68}$Ga DOTATATE PET/CT may be useful as a complementary modality in combination with standard imaging.

• “Flip-flop” pattern is observed: In comparison with FDG-PET, the lower grade tumours demonstrate higher uptake of $^{68}$Ga DOTATATE whilst the higher grade tumours are more FDG-avid.

• $^{68}$Ga DOTATATE PET/CT may be helpful in the selection of suitable candidates for targeted radionuclide therapy.