Head and Neck Cancer: Nuclear Imaging

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Fellowships
Lecture Outline

- Introduction
- HPV related HNSCC
- Patterns of Tumor spread
- Neck Nodal Levels
- Standardized therapy assessment
- Pitfalls
The Key Question

Is the primary treatment surgery or chemoradiation therapy?
Background: HN Cancer

- In US
  - 6th most common cancer
  - > 90% SCC
  - 45,000 new cases of HNSCC / year
  - 11,000 die / year
  - Medical cost $ 3.2 billion / year

Incidence & Mortality Rates

Lip, oral cavity, larynx
Incidence & Mortality Rates

Tongue and Oropharynx

Tongue and Oropharynx

Tongue

Oropharynx & Tonsil

Tongue

Oropharynx & Tonsil

Year of Diagnosis

Year of Death

Rate per 100,000


Risk Factors
- Alcohol
- Smoking
- HPV - 16

HNSCC Management

HNSCC

40%
Early

T1-T2 N0 M0

40%
Single Modality Therapy: Surgery or RT

55%
Advanced

T3 - 4
N1-3 M0

55%
ChemoRT +/- Surgery

5%
Metastatic

M1

Palliative chemoRT
Indication I: Detecting Unknown Primary

• PET is recommended for detection of unknown when other modalities (CT or MRI fails)
Indication I: Detecting Unknown Primary

- Detects 25% - 40% of unknown primary tumors after a negative CT/MRI/Endoscopy
Indication II: Staging

- Anatomical staging with contrast enhanced CT / MRI
- PET/CT for stage III and IV disease
Indication II: PET/CT & Stage

- Stage I: Not Indicated
- Stage II: Controversial
- Stage III & IV: Indicated

Clinical practice: If the risk of nodal or distant metastasis is high, then PET/CT is indicated.
What the surgeons want to know

- Extent of primary
- Midline
- Adjacent structures
- Local & distant metastases

Courtesy: Hugh Curtin MD
Staging: Indicated
Nodal Staging
Indication III: Post CCRT Assessment

- If clinical response (4-8 weeks):
  PET/CT: 12 weeks post therapy for patients treated with CCRT

- If suspected residual / progression:
  CT/MRI with contrast at 4-8 weeks; consider PET/CT
Therapy Paradigm I

Patients treated with CCRT only

Pre therapy
- Baseline Staging
- Contrast enhanced PET/CT

CCRT
- 12 week post therapy
- Contrast enhanced PET/CT

Post therapy Follow up
- 24 month follow up

- Patients treated with CCRT only

- Pre therapy
  - Baseline Staging
  - Contrast enhanced PET/CT

- CCRT
  - 12 week post therapy
  - Contrast enhanced PET/CT

- Post therapy Follow up
  - 24 month follow up
Indication IV: Follow up

• Imaging follow up within 6 month of treatment completion
HPV Related HNSCC
Case: HPV OPSCC

Tahari et al 2013. CNM.
Primary Sites

- Sinonasal: 30%
- Oropharynx: 80%
- Hypopharynx: <1%
- Oral cavity: <1%
- Larynx: <1%
HPV Related HN SCC

- Younger median age
- Oropharyngeal anatomical site (70-80% are HPV related)
- Small primary tumors
- High neck nodal involvement
- Usually not keratinized and have prominent basaloid features
- Usually do not have typical risk factors
HPV Related OPSCC stage III / IV

- Improved performance status and survival
  - Reduced risk of recurrence
  - Improved overall survival
- More than 80% are ‘cured’
- More response to radiation
- A subset has aggressive phenotype: Propensity for distant metastasis and death
Unusual Distant Metastasis

40 year old man, HPV-positive left tonsil primary
Delayed Disseminated Metastasis
• A porous basement membrane
• A propensity for small (even occult) carcinomas to metastasis in the absence of clear cut stromal invasion
Well differentiated
Moderately differentiated
Poorly differentiated

‘Basaloid’

‘Well differentiated’ cancer despite its histological features of poor differentiation
Prognosis

- Earlier survival observations not true for all HPV related OPSCC
- Small cell variant
  - Rapidly progressive
  - Poor survival
  - Smoking related
Tumor Locations & Spread
Neck Spatial Anatomy

- Oral Cavity
- Nasopharynx
- Oropharynx
- Larynx
- Hypopharynx
Neck Nodal Levels

- Level I
- Level II
- Level III
- Level IV
- Level V
- Level VI
- Level VII

Som, P. M. et al. AJR. 2000;174:837-844
Special CT Techniques

W: 56
L: 342

W: 60
L: 120
Special CT Techniques
Oral Cavity
Tumor Locations: Lateral Tongue
Tumor Locations: Anterior Tongue
Anterior & Lateral Tongue

- Does the tumor cross the midline?
- Does the tumor extend to:
  - Floor of the mouth
  - Base of tongue
  - Glosso-tonsillar sulcus
- Mandibular invasion?
- Common nodal spread:
  - Levels I, II & III
  - Ipsilateral – 65%
  - Contralateral – 12%
Anterior & Lateral Tongue

- Does the tumor cross the midline?
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Tumor Locations: Floor of Mouth
Tumor Locations: Buccal Surface
Anterior & Lateral Tongue

- Does the tumor cross the midline?
- Does the tumor extends to
  - Oral tongue
  - Base of tongue
- Mandibular invasion?
- Does the tumor extend to sublingual space – evidence for Wharton’s duct blockage?
- Common nodal spread
  - Levels I & II
  - Ipsilateral – 60%
  - Contralateral – 8%
Level I

- Nodes lie just below the mandible
- Submental nodes (1A)
- Submandibular nodes (1B)
- Drainage:
  - Anterior oral cavity
  - Face
  - Lip
  - Sinonasal
Level II

- Most frequently involved nodal level
- Skull base to the level of hyoid bone.
- Internal jugular and spinal accessory chains
- Limited by posterior edge of submandibular gland and posterior edge of the SCM
Level II

- II A: anterior to IJV
- II B: posterior to IJV separated by fat plane

Drainage:
- Posterior oral cavity
- Oropharynx
- Supraglottic larynx
- Parotid glands
Tumor Locations: Retromolar Trigone
Tumor Locations: Retromolar Trigone

- Unique pattern of spread
- Buccinator muscle
- Superior pharyngeal constrictors to tonsil
- Pterygomandibular raphae to nasopharynx and skull base
- Bone erosion
- Level I, II & III nodes
Tumor Locations: Retromolar Trigone

- Pteryomandibular raphe – fascial thickening
- Between buccinator anteriorly and superior pharyngeal constrictor posteriorly
- Potential route of spread to
  - Oral cavity
  - Oropharynx
  - Buccal space /masticator space and nasopharynx
Oropharynx

- Base of Tongue
- Lingual Tonsil
- Palatine Tonsil
Oropharynx: Tumor Spread

- Extension to soft palate
- Extension to posterior or lateral pharyngeal wall
- Antero-inferior extension to glosso-tonsillar pillar and tongue
- Postero-inferior extension to hypopharynx
- Parapharyngeal space
- LN: Levels I-V
  - Ipsilateral 58-76%
  - Contralateral 13%
Tumor Locations: BOT / Lingual Tonsil
Tumor Locations: Palatine Tonsil
Tumor Locations: Palatine Tonsil
Spatial Anatomy: Larynx
Spatial Anatomy: Larynx
Pyriform Sinus SCC
Level III

- Hyoid bone to inferior border of cricoid cartilage
- Lateral to the larynx
- Posterior: posterior edge of SCM
- Drainage:
  - Glottic
  - Subglottic
  - Hypopharyngeal
Level IV

- Inferior border of cricoid to thoracic inlet
- Posterior: Posterior border of SCM
- Supraclavicular:
  - levels IV & V
  - Difficult area for CT / MRI
  - PET is very useful
Level IV

- Drainage:
  - Rarely involved alone
  - Subglottic
  - Thyroid
  - Upper esophageal
Level V

- Posterior triangle nodes
- Posterior to the posterior edge of SCM
- Rarely involved in non advanced HN cancer
- Drainage:
  - NPH
  - Skin ca
Level V

- Posterior triangle nodes
- Posterior to the posterior edge of SCM
- Rarely involved in non advanced HN cancer
- Drainage:
  - NPH
  - Skin ca
Level VI

- Midline & anterior to viscera below hyoid bone
- Lateral: CA
- Drainage:
  - Thyroid
# Putting it together

## The four questions for assigning lymph nodes to surgical zones

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Lateral Retropharyngeal Node
# Standardizing Post therapy Interpretation

## Hopkins Criteria

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<th>Score</th>
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<td>1</td>
<td>FDG uptake at the primary site and nodes, less than background blood pool (IJV or thoracic aorta)</td>
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<td>2</td>
<td>Focal FDG uptake at the primary site and nodes greater than blood pool (IJV or thoracic aorta), but less than liver</td>
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<td>3</td>
<td>Diffuse FDG uptake at the primary site or nodes is greater than blood pool (IJV or thoracic aorta) or liver</td>
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<tr>
<td>4</td>
<td>Focal FDG uptake at the primary site or nodes, greater than liver</td>
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<td>5</td>
<td>Focal and intense FDG uptake at the primary site and nodes (&gt; 3-5 times)</td>
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Hopkins Criteria: RT or CRT therapy Assessment
Patient Outcome

- **Overall Survival**
  - (log-rank, Mantel-Cox P<0.0001)
  - HR 0.046; (95% CI, 0.018-0.120)

- **Progression Free Survival**
  - (log-rank, Mantel-Cox P<0.0001)
  - HR 0.049; (95% CI, 0.022-0.109)
FDG PET/CT: HN Pitfalls
PET/CT Pitfall: I
Perineural Spread
Perineural Spread
Marrow Involvement
PET/CT Pitfall: III
PET/CT Pitfall: IV
PET/CT Pitfall: IV
Muscular Graft Uptake
Tongue Muscle Contractions
PET/CT Pitfall: V
Parotid Gland FDG Signatures

- Normal
- Diffuse
- Pleomorphic
- Warthins
- SCC
- Adeno Ca
- Acinic Cell Ca
- Hidradeno Ca
PET/CT Pitfall: VI
Glosso-Tonsillar Ligament Rupture
Timing of FDG PET/CT

- Conventional Radiation: 12 weeks
- Cyberknife Radiosurgery: 8 weeks
- Chemotherapy: Before the next cycle
- Induction Chemotherapy: 3 weeks
- Surgery / Biopsy: 2 weeks
• Detecting Unknown Primary in head and neck
• Staging: Stage IIB – Stage IV
• Therapy Response Assessment: 12 weeks post therapy (use standardized method – Hopkins Criteria)
• Follow up: Only when symptoms or signs suggests; no routine surveillance scans
• Pitfalls: Watch for these!