Postoperative radiation therapy for cancers of the head and neck: indications, results, and future directions

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Outline

• What is radiation therapy?
• Why might radiation be recommended after surgery?
• A typical course of radiation
• Strategies to minimize toxicity
• Future directions
A Brief History Lesson

Dr. Wilhelm Röntgen  First medical x-ray, 1895

The origins of therapeutic radiation

Antoine Becquerel  Marie and Pierre Curie
Early Treatment Units

- Limitation: inability to produce high energy, deeply penetrating beams
- Difficult to treat deep-seated tumors without excessive skin toxicity

Linear Accelerator

- Radiation customized to the needs of the patient and area to be treated
- Electrons: superficial
  - Skin cancers
  - Spares deep tissues
- Photons: deeply penetrating
  - Treats deep-seated tumors
  - Spares the skin
Therapeutic vs. diagnostic radiation

<table>
<thead>
<tr>
<th></th>
<th>Therapeutic</th>
<th>Diagnostic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intent</td>
<td>Cancer therapy</td>
<td>Image acquisition</td>
</tr>
<tr>
<td>Source</td>
<td>Linear accelerator, Cobalt-60</td>
<td>X-ray, CT</td>
</tr>
<tr>
<td>Energy</td>
<td>High energy (megavoltage)</td>
<td>Low energy (kilovoltage)</td>
</tr>
<tr>
<td>Frequency</td>
<td>Daily</td>
<td>Once</td>
</tr>
<tr>
<td>Tissues exposed</td>
<td>Areas of disease receive high dose. Ability to minimize dose to normal dose</td>
<td>Uniform dose to all tissues in the field</td>
</tr>
</tbody>
</table>

Linear accelerator

- Gantry
- Imaging Panel
- Treatment Couch
Outline

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“I just went through a major surgery. My surgeon that he/she “got it all”. Why am I seeing you to discuss radiation? The reason I chose to undergo surgery was so that I would not need any more treatment.”

Postoperative radiation (PORT): rationale

- Surgery + postoperative radiation: common strategy for management of locally advanced, but resectable cancers.
- Historically, radical neck dissection alone was the mainstay of treatment
- Recurrent disease after neck dissection = ominous
- Indications: high risk surgical findings
  - Disease in the lymph nodes
    - Extracapsular extension, size > 3 cm, # nodes involved, opposite neck node involved
  - Resection margins
  - Lymphovascular invasion
  - Perineural invasion
Postoperative radiation: results

- Consistently been shown to decrease the risk of locoregional disease recurrence
- Improvement in survival?

- Comparison of 2 groups of patients
  - Neck dissection + PORT
  - Neck dissection alone

- Significant differences favoring addition of PORT with respect to recurrences in the dissected neck (figure 1), or any neck recurrence (figure 2)

Lundahl et al. 1998
PORT also significantly improved survival from head and neck cancer as well as overall survival.

Chemotherapy + Radiation

- Indicated for high-risk pathologic findings at time of surgery
  - Residual disease (Positive margins)
  - Extracapsular extension

- 2 randomized trials
  - Survival benefit with chemotherapy

- To be discussed in further detail by Dr. Ezra Cohen
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Initial Consultation

- Pre-RT evaluations: dental, PEG tube, nutrition, speech/swallow
- Treatment planning session: CT, PET/CT, MRI
- Daily radiation
Initial Consultation Visit

- History, review of diagnostic workup, surgical results
- Physical exam/evaluation
- Discuss indications for radiation
  - Risk of disease recurrence
  - Role of radiation in reducing risk
  - Benefits/toxicity
- Schedule pre-radiation evaluations and treatment planning session

Treatment-related side effects

<table>
<thead>
<tr>
<th>Acute</th>
<th>Late</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry mouth, thick saliva</td>
<td>Dry mouth</td>
</tr>
<tr>
<td>Skin irritation</td>
<td>Cavities</td>
</tr>
<tr>
<td>Taste changes</td>
<td>Damage to the mandible</td>
</tr>
<tr>
<td>Fatigue</td>
<td>Hypothyroidism</td>
</tr>
<tr>
<td>Difficulty swallowing</td>
<td>Difficulty swallowing</td>
</tr>
<tr>
<td>Sores in the mouth/throat</td>
<td>Malignancies secondary to RT</td>
</tr>
</tbody>
</table>
Initial Consultation

Downward arrow

Pre-RT evaluations:
dental, PEG tube, nutrition, speech/swallow

Downward arrow

Treatment planning session: CT, PET/CT, MRI

Downward arrow

Daily radiation

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Pre-RT Evaluations

- Dental
  - Fluoride trays
  - Moulds
  - Extractions, if needed
- Nutrition
  - PEG tube insertion
- Speech and swallow evaluation
  - Exercises
Initial Consultation

↓

Pre-RT evaluations: dental, PEG tube, nutrition, speech/swallow

↓

Treatment planning session: CT, PET/CT, MRI

↓

Daily radiation

Treatment Planning (Simulation)

• Acquires images to assist in designing radiation
  • Identify tumor and normal tissues

• CT scan
  • PET/CT
  • MRI

• Mask immobilization
• Contrast administration
PET-CT Simulation
PET-CT Simulation

PET-CT Simulation
PET-CT Simulation

PET-CT Simulation
Initial Consultation

Pre-RT evaluations: dental, PEG tube, nutrition, speech/swallow

Treatment planning session: CT, PET/CT, MRI

Daily radiation

Details of Radiation

- Typical course ~ 6 weeks
- Outpatient
- 5 days/week
- Total dose ~ 60-66 Gray
- Time spent on table: 15-30 minutes
- Weekly visits with physician
Daily imaging: image guided radiation therapy (IGRT)

Cone-beam CT
IGRT

- Daily images acquired on the machine compared to digitally reconstructed images from simulation
- Look for any changes which may have occurred either due to:
  - Weight loss
  - Mass shrinking
  - Internal organ motion
  - Human error
- Shifts applied to patient (without even going into the room!)
- Verify with imaging on a regular basis (daily, weekly)
- Treat the patient safely and reliably

Techniques: conventional RT
Techniques: intensity-modulated radiation therapy (IMRT)

- Unlike conventional approaches, IMRT conforms the prescription dose to the shape of the target in 3 dimensions, thereby reducing the volume of normal tissues receiving high doses and thus the risk of potential side effects.

IMRT: Head and Neck Cancer

[Image showing IMRT dose distribution for Head and Neck Cancer]
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### Acute Toxicity

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<th>Radiation Technique</th>
<th>Late toxicity</th>
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<td>Weekly visits</td>
<td>Radiation Technique</td>
</tr>
<tr>
<td>Supportive care: medications, hydration, nutritional support, swallowing exercises, support groups</td>
<td>Compliance with followup: speech/swallow, dental</td>
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**Radiation Technique**

**Weekly visits**

**Supportive care: medications, hydration, nutritional support, swallowing exercises, support groups**

**Radiation Technique**

**Compliance with followup: speech/swallow, dental**

**Physical, speech therapy, exercises**

**Target**

- **Left parotid**
- **Target**
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Future Directions: Proton Therapy

Perelman Center for Advanced Medicine, Roberts Proton Therapy Center
The Physics of Protons

X-rays deliver a greater dose outside the target for the same dose within the target volume as protons.

Depth dose curves for protons and photons

- **Protons**
- **Photons**

Additional Dose outside the target delivered with Photons

Proton "Spread Out Bragg Peak"

10 MeV photons

Tumor

X-rays deliver a greater dose outside the target for the same dose within the target volume as protons.
Evidence of Distal Range Stopping

Summary

- Radiation therapy has been used for over 100 years in the treatment of cancers
- Postoperative radiation is indicated for high risk features discovered at time of surgery, significantly reducing the risk of disease recurrence
- Radiation treatment planning utilizes state of the art technology and imaging, to optimize treatment of disease while minimizing doses to normal tissues
- Daily evaluation and repositioning with image guidance needed to ensure accuracy
- IMRT may decrease toxicity of treatment, better preserve normal function
- Future directions: safe escalation of dose, reduction of normal tissue exposure, development of agents that selectively sensitizes tumor cells to radiation