MEDICAL AND RADIATION ONCOLOGY FOR SURGEONS

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Objectives

• To introduce the principles of radiotherapy and systemic therapy
• To provide a *practical* overview of radiation oncology
  – Oncologic history relevant to potential radiation treatment
  – Common radiotherapy terminology
  – Cancer Emergencies
• To introduce the concepts of team care in cancer
  – Highlight the importance of surgeon/RO/MO communication & decision making
• To summarize practical considerations for multimodality cancer care
Radiotherapy

• Use of *ionizing radiation* to treat disease (usually malignancy)
  – Kill cancer cells via DNA damage

• Ionizing radiation
  – high energy radiation that can damage DNA required to grow and divide
A Small Amount of Physics
Electromagnetic spectrum
Ionizing particles

- **Uncharged:**
  - Photons
  - Neutrons

- **Charged:**
  - Protons
  - Alpha particles
  - Heavy ion therapy
Ionizing particles

- **Uncharged:**
  - Photons
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  - Heavy ion therapy
Ionizing Radiation Target = DNA

- Direct damage – Ionizing radiation directly strikes DNA
- Indirect damage - Ionizing radiation strikes water resulting in the formation of oxygen radicals which can form cross-links with DNA and interfere with normal DNA replication
Cellular effects of Radiation

Downstream effects

- Perturbation of cellular homeostasis
  - Cell death despite inadequate DNA damage
- Cytokine release
- Anti-angiogenesis molecules
- Induced apoptosis
Aims of Radiotherapy

- **Aim:** To damage/kill as many cancer cells possible while limiting damage to nearby normal cells

- **Treatment approaches:**
  - **Radical/Curative**
    - High dose, to cure sensitive tumors (e.g., cervix, nasopharynx)
  - **Neo-adjuvant/Adjuvant**
    - Moderate/High dose
    - Usually employed in conjunction with surgery to remove tumor mass
  - **Palliative**
    - Low dose (usually limited # of treatments)
    - relief of symptoms with minimum toxicity (e.g. bone metastases)
Definition of “targets” in radiation therapy

A. Gross tumor volume (GTV)
B. Clinical target volume (CTV)
C. Planning target volume (PTV)
D. Treatment portal volume
Contouring target structures
Functional imaging helps define targets

CT/PET
Radiation Delivery Modalities

• External beam
  – Linac, gamma knife, cyberknife, tomotherapy
  – (protons)
• Brachytherapy
  – Permanent seeds in prostate
  – High-dose rate temporary placement for
    • cervix cancer
    • lung
• Systemic
  – Iodine$^{131}$, Strontium, radioimmunotherapy
Brachytherapy
Cervix and Prostate

PROSTATE IMPLANT

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Brachytherapy: Breast
Brachytherapy:
Soft tissue Sarcoma

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Teletherapy: 2D radiation therapy
Teletherapy: 3D Radiation therapy
Computerized evaluation of radiation therapy plans
Assessment of dose coverage
Complex targets?

- Targets
  - GTV (red)
  - CTV1 (blue)
  - CTV2 (yellow)

- Normal tissues
  - Spinal cord (brown)
  - Parotids (green)

- How can you treat the tumor and avoid complications?
Multileaf collimation
Intensity modulated radiation therapy
Radiation Treatment Process

1. Consent
2. Immobilization
3. Simulation: CT, +/- MRI, +/- PET
4. RT planning (by Rad Onc, Planner/Therapist, Physicist)
5. Quality Assurance Checks
6. Treatment Delivery (typically: M-F) -15-30 min per treatment
7. Weekly Radiation Review Clinic - assess toxicity, symptoms, questions
Patient immobilization

• Ideally, we can deliver highly accurate doses to treat tumors and spare normal tissues
• If movement occurs, the highly accurate dose may miss tumor and treat more normal tissue
• Thus, we try to keep the patient in the same position each treatment
IMRT requires highly accurate immobilization
Immobilization
Simulation

CT scan
+/- MRI
+/- PET
External Beam Treatment Units

Gamma Knife
(Perfexion)

Cyberknife
Factors to Consider for Radiotherapy

• Patient Factors:
  Contraindications, comorbidities, performance status/mobility, ability to cooperate, convenience/QOL

• Tumour Factors:
  Is the tumour radiosensitive?

• Normal Tissue Factors:
  Is the volume needing radiation safely encompassable?
Dose and Fractionation

- Dose is prescribed in Gy or cGy (1/100 Gy)
  - 1 Gy = 100 cGy = 100 rad = 1 J/kg

- Fractionation is the schedule at which the total dose prescribed is actually delivered
  eg. 20 Gy in 5 fractions daily
Radiation Toxicity

• Radiotherapy is a local treatment and side effects are generally localized to the area of the body receiving radiation
  – Think anatomically – what tissues is the radiation passing through?
  – The one general side effect is fatigue

• There are acute, sub-acute and late toxicities
  – Acute: 2-8 weeks
  – Subacute: 2-12 months
  – Late: years – decades later
    • risk of secondary cancer
Radiation Planning
What organs may experience side effects?

- Skin
- Breast
- Chest wall muscles
- Ribs
- Lungs
- Heart
What side effects may occur with whole brain radiation?

- Fatigue
- Hairloss/scalp irritation
- Headache
- Nausea
- Seizure
- Focal neurological symptoms
- Ear (decreased hearing, pain/pressure)
Modern Cancer Management

- Continuum of care:
  - GP-Specialists-Community care
- MDTs – shared decision making (upfront)
- Multimodality treatment
- Multiple lines of salvage
- Minimally invasive (Surgery and RT)
- Outpatient treatments
- Oligometas and oligoprogression
Practical Aspects of Multimodality Treatment

• Timing:
  – Chemo & RT (what is safe to combine)
  – Interval to and from surgery
  – Avoiding breaks in treatment
  – Managing when it doesn’t go to plan

• Communication
  – Before starting therapy
  – Facts which may alter the plan
  – Trusting your team

• MDTs
Surgical Innovations Driving Practice Change

• New areas of research
• News options for management
• Focus on QOL/function
• Treatment de-escalation
Multi-Modality Cancer Care

• A few examples:
  – HN cancer
  – Lung cancer
A Case of T4 Larynx ca

- 61yo man present to ER in respiratory distress and receives a trach
- Biopsy demo SCC
- On scope no evidence of mucosal disease, submucosal fullness and fixed right hemilarynx
- CT HN:
  - There is a large mass in the right aspect of the postcricoid larynx with contiguous extension across the widened right thyroarytenoid, to infiltrate along the right true vocal cord and the right and posterior aspect of the subglottis. Erosion of cricoid and thyroid cartilages
Larynx Ca
What Factors for Decision Making?
What Factors for Decision Making?

• Functional status: speaking, swallowing

• Disease control (other staging clear)

• Co-morbidities – ability to tolerate GA or radical Chemo/RT
A Case of T4 Larynx ca

- Joint meeting with patient, family, ENT surgeon and RO

- Plan for primary laryngectomy following by RT (± chemo)
  - Speaking
  - Swallowing
  - Tumor control
Trimodality: INT 0139

- Intergroup 0139
- IIIA (pN2)
- CRT vs CRT + Surgery
- All pts rec’d EP+45 Gy.
- No progression: randomized to resection vs. RT to 61 Gy
- Median PFS: 12.8 vs. 10.5 mo, favor surgery
  - Post-op deaths in surgical pts, especially post-pneumonectomy
  - Lobectomy: median survival 34 vs 22 mo, favor surgery

Trimodality: INT 0139

OS: Lobectomy vs Pneumonectomy

MS 33 vs 22 months (P=0.002)

A Case of IIIA NSCLC

• 70yo man CXR RUL nodule
• PET: RUL 26x21mm SUV 12.9; ST 7 = SUV9
• EBUS + ST 7 SCC
What Factors for Decision Making?
Stage I

• Surgery (lobectomy)
  – But this may change!

• Radiation:
  – SBRT
  – Hypofractionation
  – Conventional fractionation

Ginsberg, Ann Thoracic Onc, 1995
Stereotactic radiosurgery
Radiation Oncology Emergencies

• Main emergencies:
  – Cord compression (nerve compression)
  – Brain metastases
  – SVC obstruction

• Know the diagnosis if at all possible:
  – likelihood of response
  – selection of treatment modality
Radiation Oncology Emergencies: Cord Compression

- Usually presents with pain (before neurologic damage)
- Call now. I don’t care if it’s 3am. Call.
- Also call Neurosurgery

- Same logic applies to other progressive loss of neurologic function situations
  - Blindness
  - Arm/leg weakness thought to be peripheral rather than central

- RT – decompresses lesions by de-bulking tumors

- Radiation dose: 20Gy / 5#
Radiation Oncology Emergencies: Brain metastases

- Largely a function of size/location:
  - No shift/herniation
  - Edema/shift/herniation
    - Often best managed with surgical decompression

- RT – decompresses lesions by de-bulking tumors

- If diagnosis is known, can start steroids

- Radiation dose: 20Gy / 5#
Radiation Oncology Emergencies: SVC obstruction

• Usually presents with upper extremity/face swelling

• RT – decompresses lesions by de-bulking tumors
  – Have to be able to lie down nearly flat for treatment
    • SOB!

• Stenting is faster, so do that if very symptomatic.

• Steroids may help

• Radiation dose: 20Gy / 5#
Questions?

• About this lecture?
• About radiation oncology?
  – As a career?
• About opportunities for research projects?
• About… anything?

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