Treatment Modalities of Radiation
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Outline
• History of radiation therapy
• Who gets radiation therapy
• Indications for radiation therapy
• Types of radiation and what does radiation does
• Review treatment timeline for a patient
Review role of oncology nurse
Discuss radiation safety precautions
Discuss management of side effects
Review early and late side effects of radiation
NCCN Toxicity Guidelines
RTOG Toxicity Guidelines
ONS PEP Resources

Radiation Oncology Timeline

Radiation oncology: a century of achievements
Jacques Bernier, Eric J. Hall & Amato Giaccia
Nature Reviews Cancer 4, 737-747 (September 2004)

1920s-1930s: Battle on fractionation

- 1930-1950's Radiation for Hodgkin's disease
- 1970's Brachytherapy implantation
- 1975-1980 Glioblastoma (GBM)
- 1977 Breast conservation therapy

La costante tentazione dei trattamenti ipofrazionati: breve cronistoria dei modelli biologici e degli effetti clinici
• 1981 Inoperable cancer treated with concurrent chemotherapy and radiation

• Late 1990’s IMRT Radiation

• 1999 PCI (prophylactic cranial whole brain irradiation) for patients with small cell lung cancer

• 2004 Neoadjuvant treatment for rectal cancer

• 2007 Hypofraction for early stage breast cancer

• 2017 Hypofractionated treatment for prostate cancer

Who gets radiation therapy?

• Cancer patients

• 50% of cancer patients will receive radiation at some point

• Most commonly treated diagnoses include breast cancer, prostate cancer, lung cancer, head and neck cancer and metastatic cancers

Indications for Radiation therapy

► Definitive (head and neck cancer)

► Neoadjuvant (rectal cancer)

► Adjuvant (breast cancer)

► Palliative (metastatic prostate cancer to bones)

► Sequential or concurrent or definitive
Radiation for benign disease

• Pituitary adenomas
• Acoustic neuromas
• Meningiomas
• Keloid scars
• Heterotopic ossification prevention
• Fibromatosis

Types of Radiation

• External beam
• 3-D conformal
• Intensity-modulated radiation therapy (IMRT)
• Tomotherapy
• Stereotactic radiosurgery (SRS)
• Stereotactic body radiation therapy (SBRT)
• Gamma knife therapy
• Cyberknife therapy
• Proton therapy
• Volumetric Arc Therapy (Rapid Arc)

Types of Radiation Beams

• Ionizing radiation is produced by electron, photon, proton, neutron and ion beams
• Beams are produced by linear accelerators
Linear accelerators

- Microwave technology speeds up electrons
- Electrons collide with a tungsten heavy metal target
- This then produces photons that penetrate deeper into the body at a target.
- Electron beams eliminate the collision with the tungsten target and then penetrate superficially

External beam radiation

- X-rays given with Linear Accelerators: electrons and photons
- Cobalt-60 machines: Gamma rays photons produced by nuclear decay
- Large particle machines or cyclotrons can produce neutrons and protons

- High energy x-ray or particles transmitted in the form of waves or particles through a material (tissue)
- Energy produced will disrupt anatomic structures.

- Direct damage of cells
- Damage causes formation of free radicals and reactive oxidation and subsequent cell death (especially in M phase)
- Mitotic cell death can occur in single and double-stranded helix so death occurs upon attempts to divide
• Normal cells can recover in between fractions

• Damage must cause more damage than the cancer cell’s ability to repopulate

RADIATION DOSING

• Dosing or measurement of amount of radiation exposure per fraction is known as a Gray (Gy)

• Small dose daily over several weeks
• Higher dose over shorter period of time
• Single fraction

Radio sensitive cells

• Breast tissue
• Bone marrow cells
• Mucosal lining of small intestines
• Sebaceous glands of skin
• Immune response cells
• All stem cell populations
• Lymphocytes

Radio-resistant cells

• Cardiac tissue
• Large arteries
• Large veins
• Mature blood cells
• Neurons
• Muscle cells
• Highly sensitive:
  Seminomas (25-30 Gy)
  Lymphomas (25-35 Gy)

• More radio-resistant
  • Head and Neck Cancers (70 Gy)
  • Prostate Cancers (70-74 Gy)
  • Glioblastomas (60 Gy)

Radio protectors
• Radioprotective amifostine, mesna

• Antioxidants

• Omega-3 fatty acids

Brachytherapy
High dose
Low dose
Temporary or permanent implantation

Radiopharmaceutical Therapy
• Ingested (Oral iodine- 131)

• Injected (IV Strontium)

• Instilled (peritoneal)
Flow process

• How do we get from start to finish?

Timeline

1. Consultation
2. Simulation
3. Contouring
4. Planning
5. Quality assurance
6. Set up

7. Delivery of RT
8. Weekly On-treatment visits and prn visits
9. Follow up visits and scans
Consultation
• Disease process and treatment options
• Performance status
• Experience with radiation (family, friends, internet)
• Co-morbid conditions
• Identify potential contraindications (lupus, scleroderma, IBD)
• PACEMAKER
• Education of process
• Informed consent
• Coordination of care

Simulation Planning
• Simulation Localization (loc) Planning Scan Mapping Scan
• Custom planning approach placing patient in a reproducible position using a CT scan – 3 dimensional virtual view of the patient
• Along with:
  • Marks and or Tattoos
  • Molds, Guards, Blocks, Boluses
  • Masks or head holders Vacuum bags (Vac-Locs)

Planning
• Fusion with MRI or PET/CT
• Contouring of target structures
• Organs at risk identification
• What is tolerance to radiation of nearby structures
• Prescribe number of treatments
• Prescribe dose per fraction
• Prescribe energy of radiation
• Prescribe total dose of radiation

Contouring
• Identify target structures
• Identify and shield organs at risk
Radiation Safety Precautions

- Radiation exposure related to distance of radioactive source
- External beam: patient is not radioactive so no risk to patient, family, personnel or public
- Shielding (lead, monitoring badges) for patient and personnel
- Brachytherapy (prostate) 6 feet away from pregnant women and do not hold small children or babies in lap for 4 months

Most patients who receive radiation are NOT radioactive

Hospital and clinics will have safety guidelines set up for working with, around and caring for patients who are receiving radiation

-Nursing Roles in Symptom Management of Radiation Side Effects
Nursing role

- Identify cancer treated, timeline and side effects related to treatment site
- Identify side effects (consider what other variables are causing side effects)- often MULTIFACTORIAL and TINCTURE of time to improve

Fatigue

- Causes include anemia, nutritional deficits, dehydration, pain, poor sleep quality, psychological stressors (family stressors, work stressors, financial stressors, depression, anxiety, confusion), concurrent treatment, medications, infections, hypothyroidism, renal dysfunction, disease progression

Treating fatigue
• Identify source (educate patient on multifactorial issues)
• Exercise
• Rest periods
• Good sleep hygiene
• Pacing one-self
• Delegation of activities/tasks
• Nutrition and hydration
• Recharge (meditate, fun or relaxing activities)

Gastrointestinal Side effects
• Anorexia, nausea, vomiting, esophagitis, mucositis, dysphagia
• Appetite stimulants (steroids, megesterol, CBD)
• Anti-emetics
• Small, frequent meals, soft foods or liquids
• Avoid strong odors
• Treat constipation
• Calorie dense meals
• Sip sip sip nibble nibble nibble nudge nudge nudge

GI
• Diarrhea (several semi formed BMs each day OR watery BMs):
  • 1. Start a BRAT diet for 1-2 days until the diarrhea improves.
  • Bananas, Rice, Applesauce, Toast, juices without pulp, broths, popsicles etc.
  • 2. Low fiber diet
  • 3. If diarrhea continues despite the low fiber diet, start over the counter lomodium-AD. Take ONLY 1 PILL with each episode of diarrhea, no more than 8 pills in a 24 hour period.

GI
• Diphenoxylate-atropine: Lomotil
• Avoid bismuth (dark stools)
• Note if on recent antibiotics? Rule out c.diff before starting on anti-diarrheals to avoid development of toxic megacolon
Perianal care

• Sitz baths
• Non-scented baby wipes
• Moisture barriers
• petroleum jelly
• zinc oxide

Radiation Dermatitis

• Reaction can begin within 1-4 weeks and can last for 2-4 weeks after finishing treatment

• Cause: loss of basal layer of cells causing shedding of epidermis and loss of sweat and sebaceous glands

RTOG Radiation Dermatitis Grading

• 0 No change
• 1 Erythema; dry desquamation, epilation
• 2 Bright erythema, moist desquamation, edema
• 3 Confluent moist desquamation, pitting edema
• 4 Ulceration, hemorrhage, necrosis
Treatment options

• General skin care for patients undergoing radiation therapy includes:
  
  • Keep the irradiated area clean and dry
  
  • Wash daily with lukewarm water and mild soap
  
  • Apply unscented, moisturizer, which you know that your skin tolerates (such as Cetaphil, Lubriderm, Eucerin, Keri, Vaseline Intensive Care, Aquaphor).

• Please DO NOT apply any lotion, cream etc. to the skin, which will be irradiated 3 hours before your radiation treatment. If you forget and do so occasionally, please DO NOT SCRUB IT OFF, as you may tear your skin.

• Please DO NOT apply sun screen/block to the radiation treatment field prior to daily radiation therapy.

• Wear loose-fitting clothes to avoid friction injuries.

• Avoid skin irritants such, as perfumes and alcohol-based lotions.

• Avoid using tape on the irradiated skin, as this can tear the skin.

• Avoid metal-based topical products, such as zinc oxide creams or deodorants containing aluminum salts.

• Avoid corn starch or baby powder in skin folds.

• Avoid sun exposure.
Product Selection for Dermatitis

- Prophylactic steroids (mometasone)
- Petroleum-based ointment (Aquaphor, Vaseline, Cerave)
- Aloe vera
- Sucralfate
- Hyaluronic acid silver dressing
- Silver sulfadiazine
- Vitamin A and E ointment/cream
- TheraCare
- Trolamine (Biafene)
- Aloe vera gel or plant
- Chamomile, almond oil, emu oil, olive oil

- Telfa dressings
- Vaseline soaked gauze
- Pain control
- Moisture control
- Refer back to Radiation Oncology versus Urgent Care if infection is suspected.

Duration of Radiation Dermatitis

- Occurs 2-3 weeks from start of treatment and can last 2-3 weeks

- Late effects include telangiectasia, atrophy, fibrosis, edema and ulceration (greater than 90 days out from radiation)

Topical Steroids as prophylaxis for radiation dermatitis

- Loucous, Lacouture, Thompson and Schneider.
- Radiation dermatitis: a prevention protocol for patients with breast cancer
- Clinical Journal of Oncology Nursing
- August 2018, Vol. 22, No 4
Other effects to consider

- Increased cerebral edema (headaches, nausea, vomiting, and neurologic changes)
- Mucositis (oral, esophageal)
- Pneumonitis
- Myelosuppression
- Alopecia
- Sexual dysfunction
- Reproductive organs
- Cystitis

What about the lungs early on and later

- Chemotherapy agents causing pulmonary toxicities:
  - Alkylating agents, anti-metabolites, nitrosureas and antibiotic drugs
  - Targeted inhibitors and immunotherapy agents

Late Toxic Effects

- Cognitive changes with memory loss

- Lymphedema
  - Axillary lymphedema 2-10% with surgery alone
  - Axillary lymphedema 13-18% with adjuvant radiation added
Ischemic Heart Disease

- Review of literature show no increased risk of death of women due to ischemic heart disease who received chest wall or breast radiation since 1980 due to advances in shielding the heart.
- Education: tobacco cessation, cholesterol, blood pressure and weight control.

Radiation induced malignancies

- RARE
- RARE
- Can occur 10-15 years later

Late Toxic Effects

- Skin: fibrosis, dryness, pigment changes, telangiectasias, contracture
- Pain of tissue
- Loss of hair and sweat gland function
- Fat necrosis of tissue
- Bone: loss of bone density, osteoradionecrosis

Pulmonary fibrosis

- Fibrosis: usually clinically silent and can be seen on CT
- Oxygen use may be needed if patient has severe COPD
- Did they receive pulmonary toxic drugs (bleomycin, oxaliplatin?)
Radiation pneumonitis

- Pneumonitis
- Can be seen 1-12 months after radiation
- Usually mild or self-limited
- Can be severe with cough, dyspnea, fever, hospitalization
- Can be treated with steroids