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Dimensions in Oncology: Radiation Therapy

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Disclosure

- We have not conflicts of interest to disclose.

Objectives

- Brief History of Radiation
- Why/How Does Radiation Work
- Types of Radiation & Radiobiology
- The Treatment Team
- A Patients Experience

A Brief History of Radiation

In 1896, Henri Becquerel discovered natural radioactivity in Uranium. His student, Marie Curie investigated and discovered other radioactive elements, like Radium

X-rays are produced by an electric machine

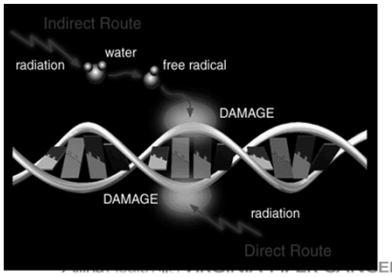
Gamma rays (radioactivity) come from certain atoms (like Uranium)

Two things that were discovered about X-rays right away

- X – rays could pass through "solid" objects to see inside.
- X-rays could be used to shrink tumors.

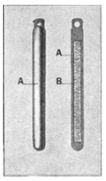
X-rays were used to see inside the body

Radiation Particles can damage molecules in a cell

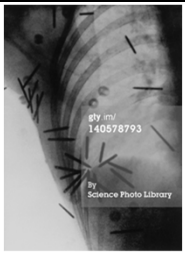


X-rays were also used to shrink tumors

Radium was also used to treat tumors



Radium Needles were placed next to tumors.



In the Early days, radiation therapy was a simple as shining X-ray "light" on a tumor

The Two Fundamental Facts of Radiation Therapy

Radiation kills cancer cells

Radiation also kills healthy cells

Early On, using radiation to treat tumors was limited by skin tolerance.

The Two Fundamental Goals of Radiation Therapy

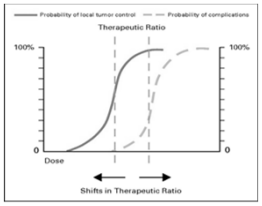
Deliver radiation to the tumor

Avoid giving radiation to normal tissue.

Radiobiology

Therapeutic ratio can be widened by several things

- Improved tumor-directed, image-guided radiotherapy planning
- Radiation sensitizers
- Chemotherapy
- Radio protectors



Patient Population & Common Diagnosis Types

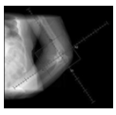
-Ages 0-100+
-Breast
-Brain Primary
-Lung
-Prostate
-Head & Neck
-GYN
-Bone & Brain Metastasis
-Pediatric Primaries
-Pancreas
-Colorectal
-Anal
-Liver
-Gastric
-Bladder
-Sarcomas
-Lymphoma
-Skin
-Esophageal

Other Uses for Radiation Therapy

Most Radiation Therapy Treatments are used to Treat Cancer

Some other things radiation is used for:

- **Keloid**
- **In-Stent Restenosis (Cardiology)**
- **Heterotopic bone formations**
- **Meningioma's**
- **AVM's**



What do these things have in common?
Cells are growing abnormally fast

Methods of Delivery

-3D Conformal
-IMRT
-Electron
-Deep Inspiration Breath Hold
-Cranial Stereotactic Radiosurgery/Radiotherapy
-Stereotactic Ablative Body Radiotherapy
-High Dose Rate Brachytherapy
-Cardiac IVB
-Theraspheres™
-Xofigo™

Radiation Oncology Team

- Radiation Oncologists
- Registered Nurses
- Nursing Assistant
- Schedulers
- Clinical Assistant
- Charge Capture Specialist
- Radiation Therapists
- Radiation Dosimetrists
- Medical Physicists

Journey of the Patient

- Consultation
- Simulation
- Planning
- Quality Assurance Testing
- Treatment
- Weekly On-Treatment Visits with Physician & Nurse
- Follow-Up

Consultation With Radiation Oncologist

Starts behind the scenes
- referral process
- gathering info

Day of consult
- check in
- nursing assistant
- visit with RN and MD

Visit with RN and MD

- Nursing – review of medications, medical history, family cancer history, social history, review of systems, and education (what to expect with planning, acute side effects).
- Reporting to the physician- pertinent info from the review of systems, how did they get here, their understanding of diagnosis, plan
- MD visit- physical exam, number of treatments, review of imaging and area to be treated, risk and benefits, professional opinion, long term or chronic side effects
- Tying it up- plan for sim, next appointment, referrals, etc.

Simulation

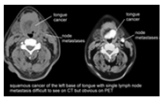
- Create daily set up
- Use many different tools to help reproduce the same position everyday
- Tattoo (or mark) 3 points one the outside of your body
- CT Scan in this position

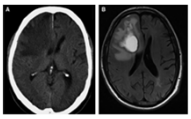
Simulation

- Bolus
- Compression
- Respiratory Gating
- 4DCT
- MRI &/or Pet/CT Imaging for Fusion

Treatment Planning (Dosimetry)

- Behind the scenes work of making the radiation plan specific for each patient- this process can take multiple days to produce an optimal plan
- Use CT, PET/CT and MRI scans to create the treatment plan (it is best if the patient is in the same position for all scans)





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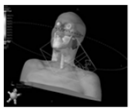
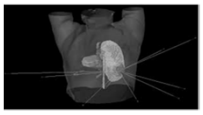
Treatment Planning (Dosimetry)

- Using multiple scans in a specific treatment planning system we create a virtual patient and can experiment with different types of plans and different beam arrangements in this virtual reality.
- The ultimate goals is to deliver the prescription dose to the tumor volume, while keeping dose low to all other critical "normal" tissues and organs





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Defining the Treatment Area

- Contour areas that need to be treated and areas that need to be avoided.
- **Area to treat:** Tumor+Margin
- **Areas to avoid:** Optic structures, Brainstem, spinal cord, normal brain tissue

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Defining the Treatment Area

- **Area to treat:** Tumor and Regional Lymph Nodes+Margin
- **Areas to avoid:** Normal Lung tissue, Heart, Esophagus, Spinal Cord, Liver

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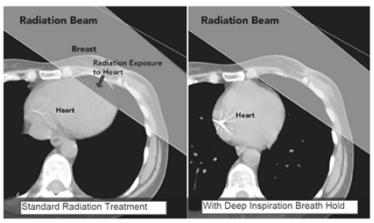
Defining the Treatment Area

- **Area to treat:** Breast Tissue
- **Areas to avoid:** Normal Lung tissue, Heart
- Having the patient take a deep breath and hold it for treatment allows decreased radiation dose to the patients heart.
- We use a tracking system to monitor and ensure accurate breaths are taken for treatment



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Treatment Prescription

- The total dose the Doctor would like to give the Tumor Volume+ Margin
- The limitations of the normal tissues and organs surrounding the Tumor

Targets	Target Description	Total Dose (cGy)	Dose per Fraction (cGy, 1/day)	Total Fractions (5/wk)	Growth (mm)
CTV	tumor bed, RIGHT medial frontoparietal convexity	5940	180	33	3

Targets	Target Description	Total Dose (cGy)	Dose per Fraction (cGy, 1/day)	Total Fractions (5/wk)	Growth (mm)
CTV-60Gy	RIGHT oropharynx; RIGHT level 2 nodal bed and adjacent nodal area within ~15 mm	6000	200	30	4
CTV-51Gy	RIGHT Level 1b, 2, 3, 4, 5 and posterior pharyngeal nodes, and LEFT Level 2, 3, and 4 nodes not otherwise covered in above targets	5100	170	30	4
CTV-66Gy	RIGHT tonsillar tumor bed with positive margin	6000 + 600 (accum: 6600)	200	30 + 3 (accum: 33)	4

53

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Respecting the tissue tolerance for each organ

Brain Glioma DVH Limit Set	
*Includes current limits for: GBM (46Gy + 16Gy), Brainstem Glioma (55.8Gy)	
Structure	Proposed
Chiasm	Max < 54Gy
Chiasm	Max < 59Gy
Optic Nerve	Max < 54Gy
Optic Nerve	Max < 59Gy
Spinal Cord	Max < 45Gy
Spinal Cord	Max < 50Gy
Spinal Cord (C1-C2)	<50% > 54Gy
Brainstem	Max < 54Gy
Brainstem	Max < 60Gy
Orbit	Max < 45Gy
Lens	<5% > 6Gy
Cochlea	Max < 45Gy
Cochlea	Max < 32Gy
Hypothalamus	<12Gy, <20Gy, Max <51Gy
Retina	Max < 45Gy

Abdominal DVH Limit Set	
*Includes current limits for: Pancreas 50.4Gy, Gastric 45Gy, Esophagus 50.4Gy	
Structure	Proposed
Small Bowel	Max < 51Gy
Liver	<33% > 45Gy
Liver	Mean < 28Gy
Liver	<50% > 35Gy
Liver	<100% > 30Gy
Kidneys - Bilateral	<45% > 18Gy
Kidney - Single	<25% > 18Gy
Spinal Cord	Max < 45Gy
Stomach	Max < 51Gy
Lung: Bilat	<60% ≥ 5Gy
Lung: Bilat	<45% ≥ 10Gy
Lung: Bilat	<30% ≥ 20Gy
Lung: Bilat	Mean < 18Gy
Heart	<25% ≥ 55Gy
Heart	<50% ≥ 45Gy
Heart	<40%>30Gy

Prostate DVH Limit Set	
*Includes current limits for: RTOG 0534, RTOG 0815, RTOG 0929	
Structure	Proposed
Bladder	<70% > 40Gy
Bladder	<50% > 65Gy
Bladder	<35% > 70Gy
Bladder	<25% > 75Gy
Bladder	<15% > 80Gy
Rectum	<55% > 40Gy
Rectum	<50% > 50Gy
Rectum	<35% > 60Gy
Rectum	<25% > 65Gy
Rectum	<20% > 70Gy
Rectum	<15% > 75Gy
Rectum	<5% > 78Gy
Small Bowel	Max < 45Gy
Femoral Heads	Max < 50Gy
Penile Bulb	Mean < 52.5Gy

54

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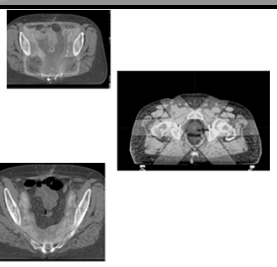
Treatment Modalities

- 3 Dimensional
- Intensity Modulated Radiation Therapy
- Rapid Arc



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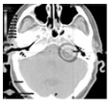
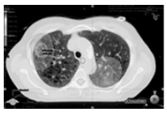
Treatment Modalities

- Stereotactic Radiation Therapy (SRS)



- Stereotactic Ablative Radiation Therapy (SABR)



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Final Chart Sign-Off

- Before any patient is treated, 4 people verify all parameters and sign off on the plan
  - Dosimetrist
  - Medical Physicist
  - Radiation Oncologist
  - Radiation Therapist

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Treatment

- First day
  - Imaging: KV, MV, CBCT
  - Measurements
  - Scheduling
  - Skin care/education
- Daily
  - Set up/imaging
  - Communication/monitoring side effects
  - Monitoring patient
  - Delivering treatment
  - Documentation

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Weekly Visits with RN/MD

- **Side effect management**– side effects correlate with the area of the body we are treating
- Fatigue
- GI/GU issues
- Pain
- Esophagitis and swallowing problems
- Skin breakdown

61

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Weekly Visit with RN/MD

- Re-education
- Emotional assessment (patient and caregiver)
- Referrals needed? (social work, cancer rehab, outside clinic, support group)

Follow-Up Visits

- May occur 1- 8 weeks after completion of treatment
- Recovery of acute side effects
- Questions on chronic side effects
- Plan going forward

Recommended Reading for Health Care Providers

- **One in Three: A Son's Journey into the History of Cancer**- Adam Wishart
- **When Breath Becomes Air**- Paul Kalanithi
- **The Emperor of all Maladies**- Siddhartha Mukherjee
- **Being Mortal**- Atul Gawande
- **The Immortal Life of Henrietta Lacks**- Rebecca Skloot

Contact Information

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