Jefferson
Philadelphia University + Thomas Jefferson University

Radiation Therapy Registry Review: Treatment Procedures

Matt Marquess MBA, R.T.(T)
Assistant Professor
Jefferson College of Health Professions
Department of Medical Imaging and Radiation Sciences
Radiation Therapy Program Director

Content Specifications

- ***5 areas to cover for registry exam***
  - ***35 Questions (increased from 25)***

A. Treatment Options
B. Verification and Application of the treatment plan
C. Treatment Machine Setup
D. Treatment Accessories
E. Treatment Administration

Jefferson | Philadelphia University + Thomas Jefferson University

A. Treatment Options

1. Chemo
2. Surgery
3. Radiation
   a) External beam
   b) Brachytherapy
4. Multimodality Treatment

A. Treatment Options

- Multidisciplinary approach
  - Tumor Boards—oncologists, surgeons, pathology, social work etc.
  - What is the best approach for that patient?
  - The approach will change if a patient is having a multi-modality approach versus a single modality
  - Example: Lower dose of radiation if chemo is adjuvant
- Are the side effects from the radiation or something else?
- How will a scar heal if it is radiated?

1. Chemotherapy

- Systemic treatment
  - Kills tumor cells but also kills other healthy cells
- Some are cell cycle specific
  - Most effective when tumor is small and divides rapidly
- Cytotoxic—the ability to kill cells

1. Chemotherapy

- Administration—depends on the drug
  - Oral: easy, requires compliance
  - Injection: patient or family can be taught, requires compliance
  - Intra-arterial: an artery near the tumor
  - Intravesicle (intracavitary): chemo delivered directly to the tumor (BCG for bladder cancer)
  - Intrathecal: delivered directly into the spinal canal, physician
  - IV: one of the most common methods

1. Chemotherapy

- Chemo drugs are classified by what they do (how they affect the cell) or where they come from
  - For example: vinca alkaloids come from the periwinkle plant and effect cells in metaphase

1. Chemotherapy Principles

- Radiosensitizers—doxorubicin (adriamycin) cardiotoxic, temozolomide for GBM
- Radioprotectors—amifostine
- Hormonal agents—block receptors on tumors that feed off of the body's natural hormones and/or lowering the hormone levels in the body that feed the tumor

1. Chemotherapy (Other Treatments)

- Immunotherapy uses the body's own immune system to destroy cancer

1. Chemotherapy

- Can be very toxic
  - Wear gloves when handling lines
  - Face shield if potential for slash
  - Can blister (vesicant)
  - Extravasation--the escape of chemo into subdermal or subcutaneous tissue and causes ulceration or tissue damage

1. Chemotherapy

Extravasation

1. Chemotherapy

- Always keep IVs above the insertion site
- Watch for kinked lines, maintain line patency (unobstructed)
- Don’t fool around with pumps, get the nurse

2. Surgery

- Localized treatment
- Can be used as a diagnostic tool
- Down-staging a tumor
- Can be used after or before chemo and/or radiation
- IORT—can give a lower total dose in one fraction and have the same affect as multiple fractions
- There are risks of tumor seeding in some surgeries
- Biopsies are a form of surgery

Jefferson | Philadelphia University + Thomas Jefferson University

2. Surgery

- Some surgeries:
  - Moh's surgery
  - Whipple—pancreaticoduodenectomy
  - Lumpectomy
  - Sentinel Node Biopsy, other biopsies. FN, CN, Incisional, Excisional
  - Mastectomy
  - Prostatectomy
  - Oopherectomy
  - Orchiectomy
  - Cryosurgery
  - Nephrectomy
  - Limb sparing surgery for STS

Jefferson | Philadelphia University + Thomas Jefferson University

2. Surgery

- Surgical clips left in tumor beds to guide treatment planning
- Electrons post lumpectomy
- Some tumors cannot be accessed safely
  - Brainstem
- Not everyone is a surgical candidate
  - The elderly
  - Poor pulmonary function
  - Previous adverse anesthesia reactions

Jefferson | Philadelphia University + Thomas Jefferson University

3. Radiation Therapy

- External beam radiation therapy
- Brachytherapy
  - See pre-recorded lecture
  - Basic principles
    - Dose to surrounding structures
    - Radiation protection issues

Jefferson | Philadelphia University + Thomas Jefferson University

4. Multimodality Treatment

- Slide 4

Jefferson | Philadelphia University + Thomas Jefferson University

B. Verification and Application of the Treatment Plan

1. Patient position
2. Isocenter
3. Treatment parameters
4. Prescription
5. Modalities

Jefferson | Philadelphia University + Thomas Jefferson University

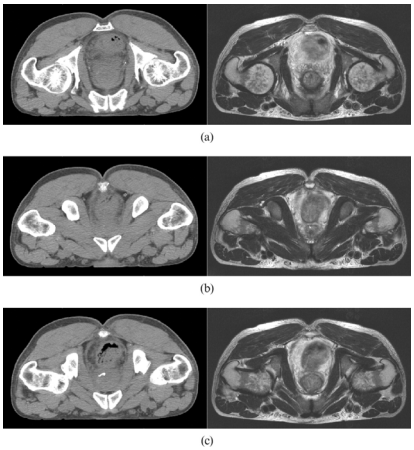
1. Patient Position

- Prone—when treat prone and why? When would not treat a patient prone?
- Supine
- Akimbo
- Pt. laying on their side—decubitus
- Reversed on the table—why?
- Frog legged
  - Where and when are these decided?

Jefferson | Philadelphia University + Thomas Jefferson University

1. Patient Position

Is this patient supine?



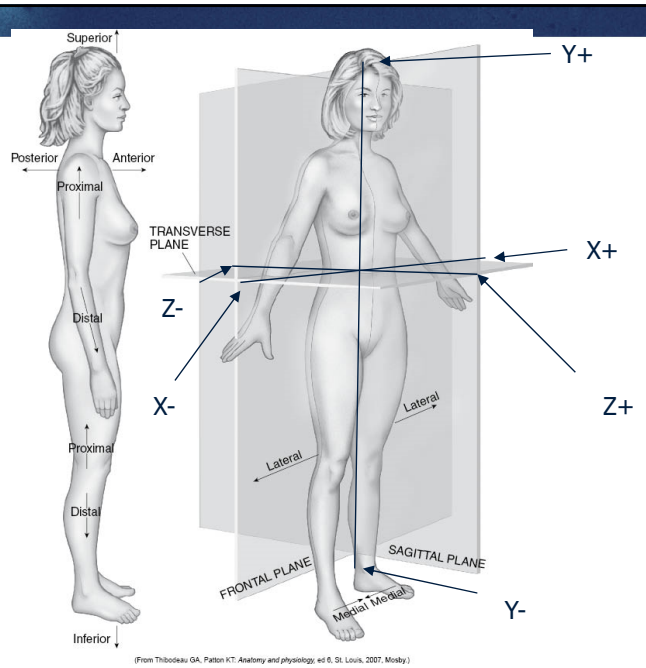
http://bjr.birjournals.org/content/85/1009/61/F1.large.jpg

Jefferson | Philadelphia University + Thomas Jefferson University

2. Isocenter

- Not the center of the tumor!
- X,Y, Z coordinates
- X is right to left
- Y is head to toe
- Z is front to back (depth)

Jefferson | Philadelphia University + Thomas Jefferson University



(From Thibodeau GA, Patton KT: *Anatomy and physiology*, ed 6, St. Louis, 2007, Mosby.)

Jefferson | Philadelphia University + Thomas Jefferson University

Washington & Leaver: Principles and Practice of Radiation Therapy, 3rd Edition

2. Isocenter

- Axis of rotation for
  - Couch
  - Collimator
  - Gantry
- As the gantry rotates around the patient the SSDs may change but the isocenter remains the same
  - * for SAD technique (also called isocentric technique)
- Benefit of using SAD vs. SSD technique?

Jefferson | Philadelphia University + Thomas Jefferson University

Jefferson
Philadelphia University + Thomas Jefferson University

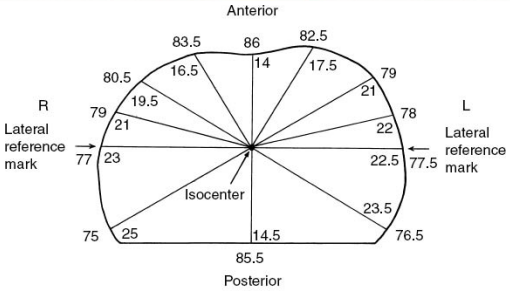


Figure 22-8. Source-skin distance (SSD) varies with the patient's separation when an isocentric technique is used. Note that, using a combination of SSD measurements, a patient's separation can be calculated. In this example, the anterior SSD through the central axis (CA) is 86 cm (depth of 14 cm) and the posterior SSD is 85.5 cm (depth of 14.5 cm). The IFD can be calculated by adding the two depths (14 + 14.5 = 28.5 cm).

Washington & Leaver: Principles and Practice of Radiation Therapy, 3rd Edition

2. Isocenter

Physician reviews a film and says the isocenter needs to move 2 cm anteriorly. What do you do?

If the SSD reads 92 before the shift, what will it read after the shift?

2. Isocenter

***Theoretically you can move the isocenter

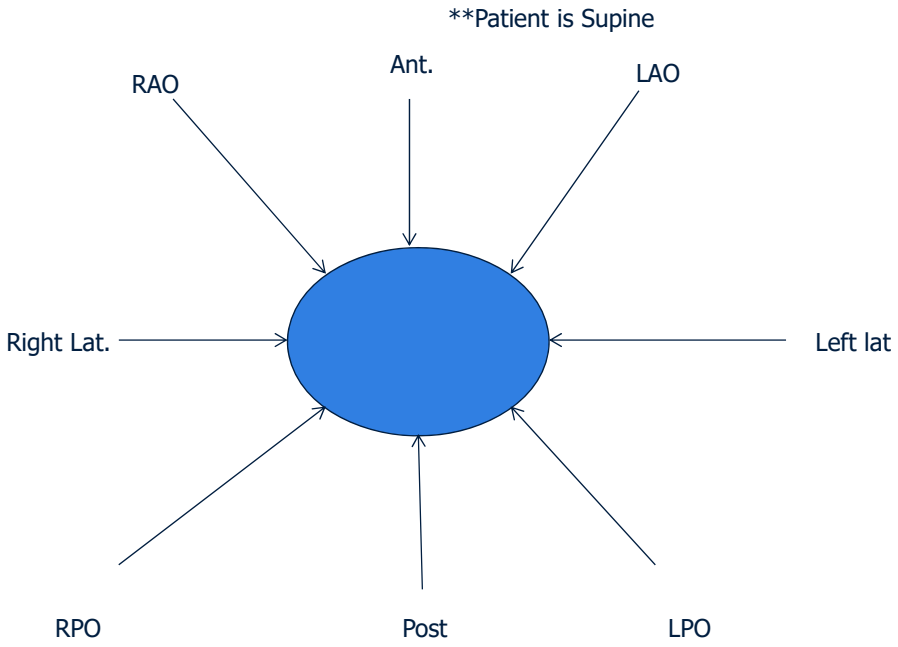
***Technically you cannot move the isocenter because it is a fixed point in space

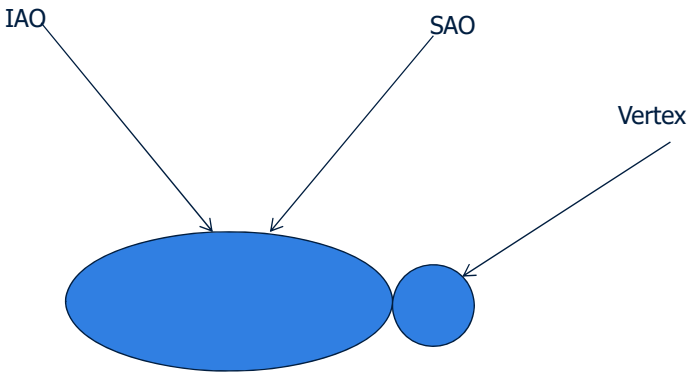
Jefferson | Philadelphia University + Thomas Jefferson University

3. Treatment Parameters

- Beam orientation
- AP/PA
- RAO, LAO, RPO, LPO, Vertex etc.
- Relation to patient position prone versus supine

Jefferson | Philadelphia University + Thomas Jefferson University





3. Treatment Parameters

- Energy
  - MV typically denotes Photons
    - Machines range from 4 MV to 25 MV
    - Some facilities may use “X” to denote energy, ex. 6X photons
    - Dual energies
  - MeV denotes electrons
    - 6 MeV to 22 MeV
    - Multiple energies
  - Mixed mode or mixed energy treatments

4. Prescription

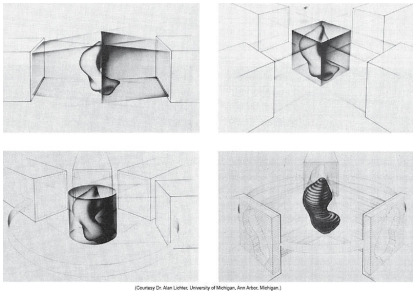
- Characteristics:
  - Similar to prescribing a therapeutic medication
  - Must be written and signed/approve by an attending Radiation Oncologist
  - No different from a drug prescription
  - Cannot treat without, no exceptions

4. Prescription—Legal Document

- Elements
  - Anatomic site, (treatment volume)
  - Energy/Mode (type)
    - Energies, MV and MeV, Co 60
  - Total dose
  - Daily dose
  - Fractionation (total number of treatments)
  - Protraction
  - Technique
    - # and orientation of beams
  - Beam entry angles
  - Modifiers
  - Bolus, every day q.d.
    - Every other day q.a.d
    - Twice a day b.i.d
- Patient positioning information
- Treatments per day
- Changes can be made during course of treatment
- No MUs
- Vary from one institution to another!

5. Modality

- 2D
  - When radiographs are used to plan treatment
  - Emergencies
- 3DCRT
  - CT based planning

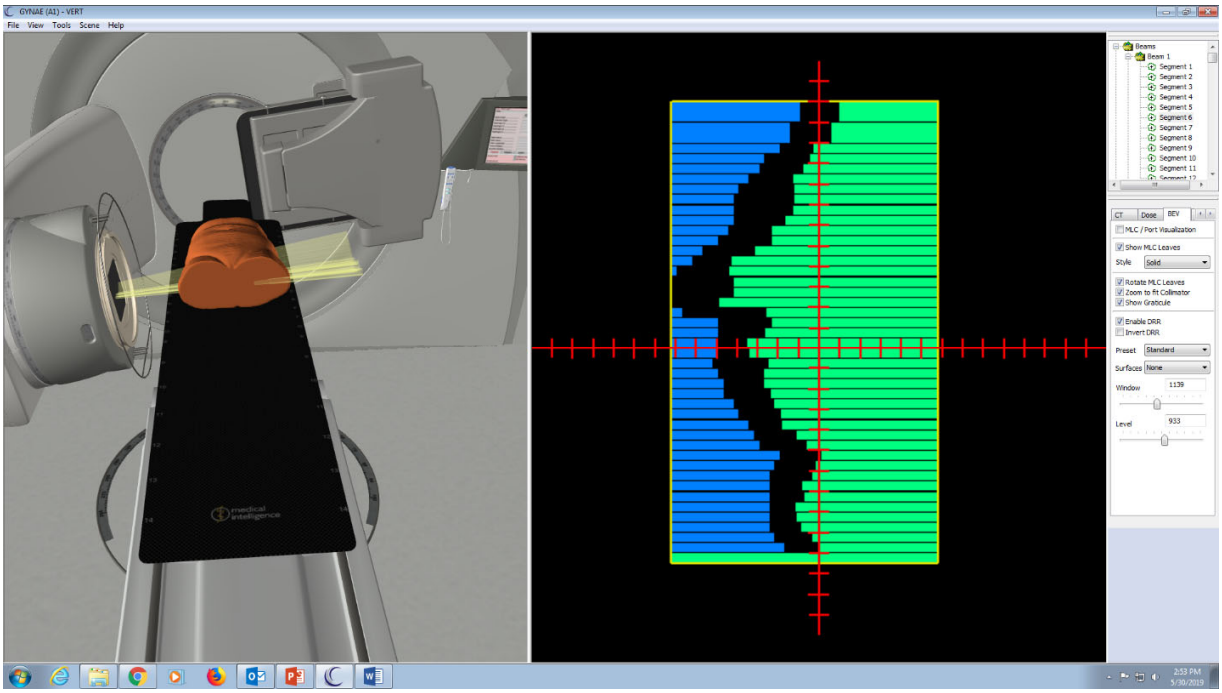


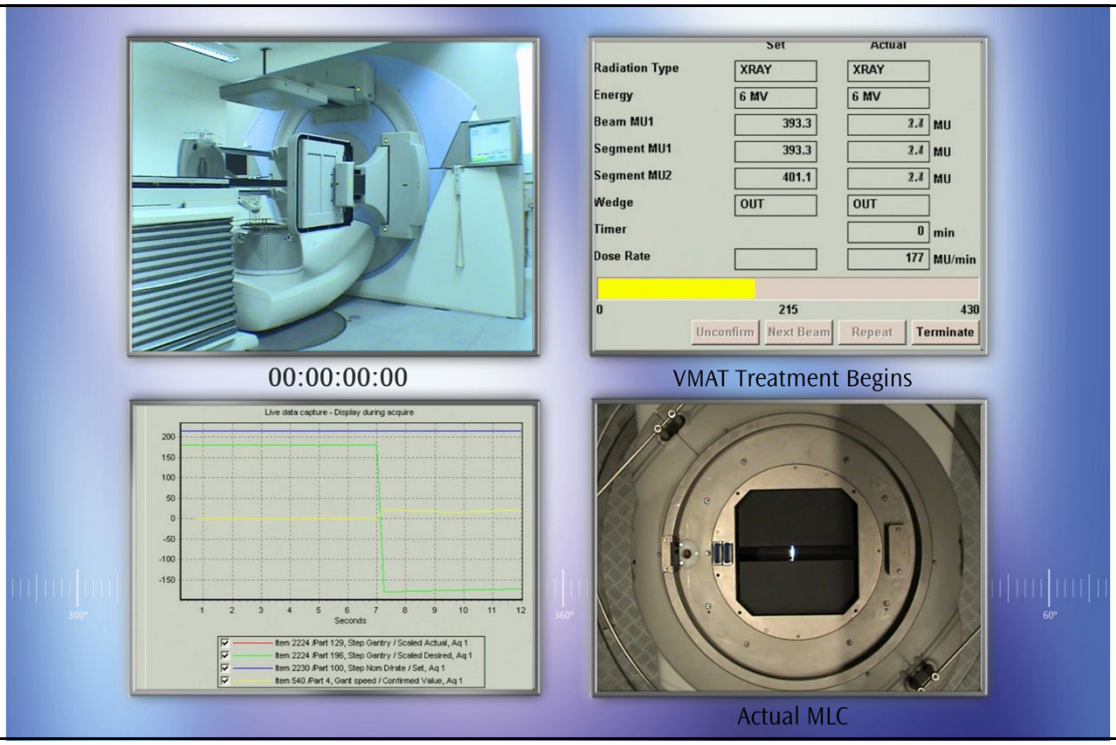
(Courtesy Dr. Alan Lichter, University of Michigan, Ann Arbor, Michigan.)

Washington & Leaver: Principles and Practice of Radiation Therapy, 3rd Edition

5. Modality

- IMRT and ARC/Rotational
  - Being used more often today than conventional 3DCRT
  - Is a sophisticated form of 3DCRT
  - Step and shoot (see next slide) vs. sliding window
  - Dynamic MLCs
  - Static vs. dynamic gantry
  - +/-0.5% transmission through MLCs
    - Interlocking tongue and groove MLC help reduce leakage




Set
Actual
Radiation Type
XRAY
XRAY
Energy
6 MV
6 MV
Beam MU1
393.3
MU
Segment MU1
393.3
MU
Segment MU2
401.1
MU
Wedge
OUT
OUT
Timer
0
min
Dose Rate
177
MU/min
0
215
430
Unconfirm
Next Beam
Repeat
Terminate
00:00:00:00
VMAT Treatment Begins
Live data capture - Display during acquire
Seconds
Actual MLC

5. Modality

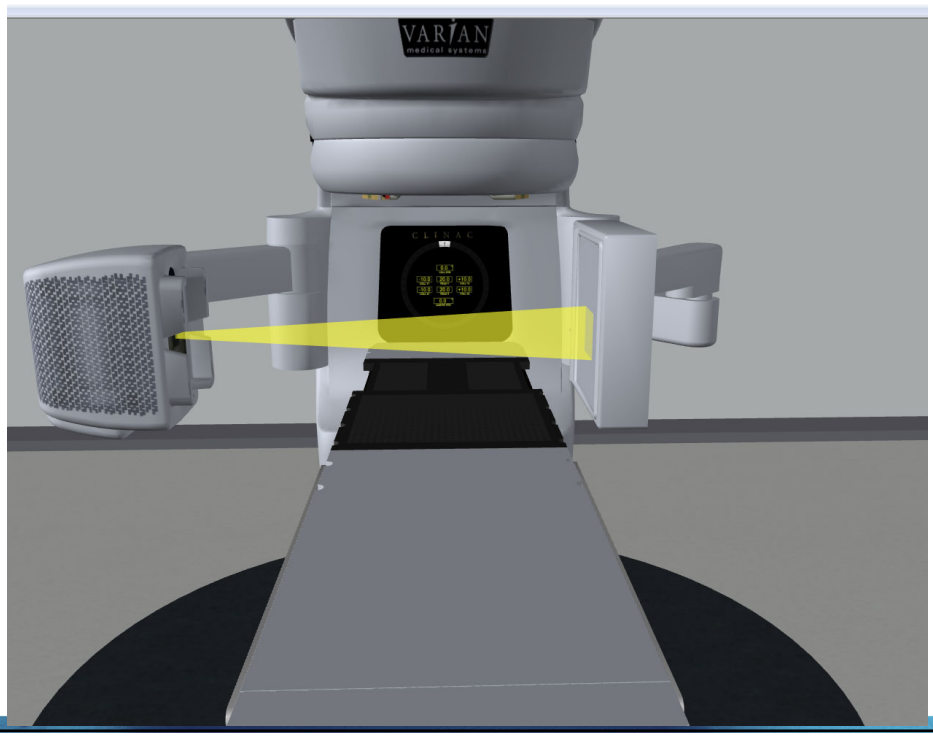
- 4D gaiting
  - 4D sim vs. 4D treatment
  - OSMS system—infra-red
- SRS, SBRT
  - Single fraction SRS
  - Immobilization for SBRT
  - Image guided techniques
  - Fiducials
  - ± 1mm tolerance

Jefferson | Philadelphia University + Thomas Jefferson University

6. Imaging Procedures

- kV imaging
  - Often referred to as kV/kV because 2 orthogonal films are taken.
  - Comparison with DRR, shifts made
  - Can view isocenter but cannot view treatment ports
  - Betters soft tissue contrast than MV portal

Jefferson | Philadelphia University + Thomas Jefferson University



6. Imaging Procedures

- CBCT—cone beam CT
- Couch does not move during acquisition
- As with all IGRT techniques the simulation images are "registered" with the isocenter.
- This allows for comparison of CBCT image and CT sim
- Can use MV or kV imaging

6. Imaging Procedures

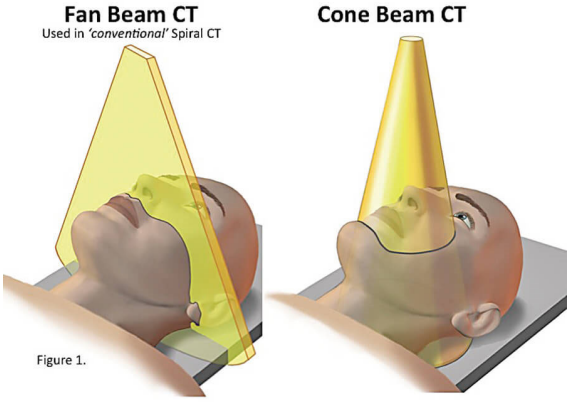


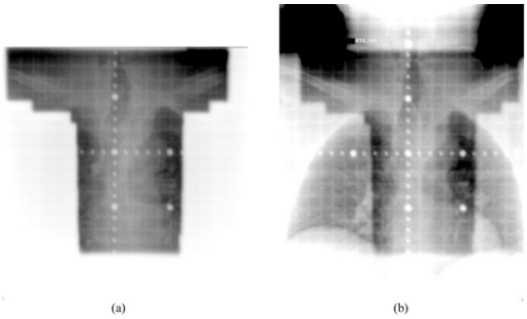
Figure 1.

Jefferson | Philadelphia University + Thomas Jefferson University

6. Imaging Procedures

- MV Imaging (Portal Images)
  - Whereas kVp and mAs are pre-set for kV/kV images, MUs must be entered for MV portal imaging
  - EPID—electronic portal imaging device
  - Can visualize isocenter and MLC patterns/beam shape

Jefferson | Philadelphia University + Thomas Jefferson University



6. Imaging Procedures

- Some other techniques
  - Ultrasound
  - Tomotherapy
  - Fiducials
  - CT on rails

Key Points

- Review the diagrams and patient positioning instructions on treatment chart/worksheet
- Review sim. and treatment machine parameters on treatment chart/setup sheet and films
- Prescription—daily dose, energy, technique, fractions, etc.
- New treatment techniques: Max. dose to tumor, minimize dose to healthy tissue, very small margins for error
- IGRT

Question?

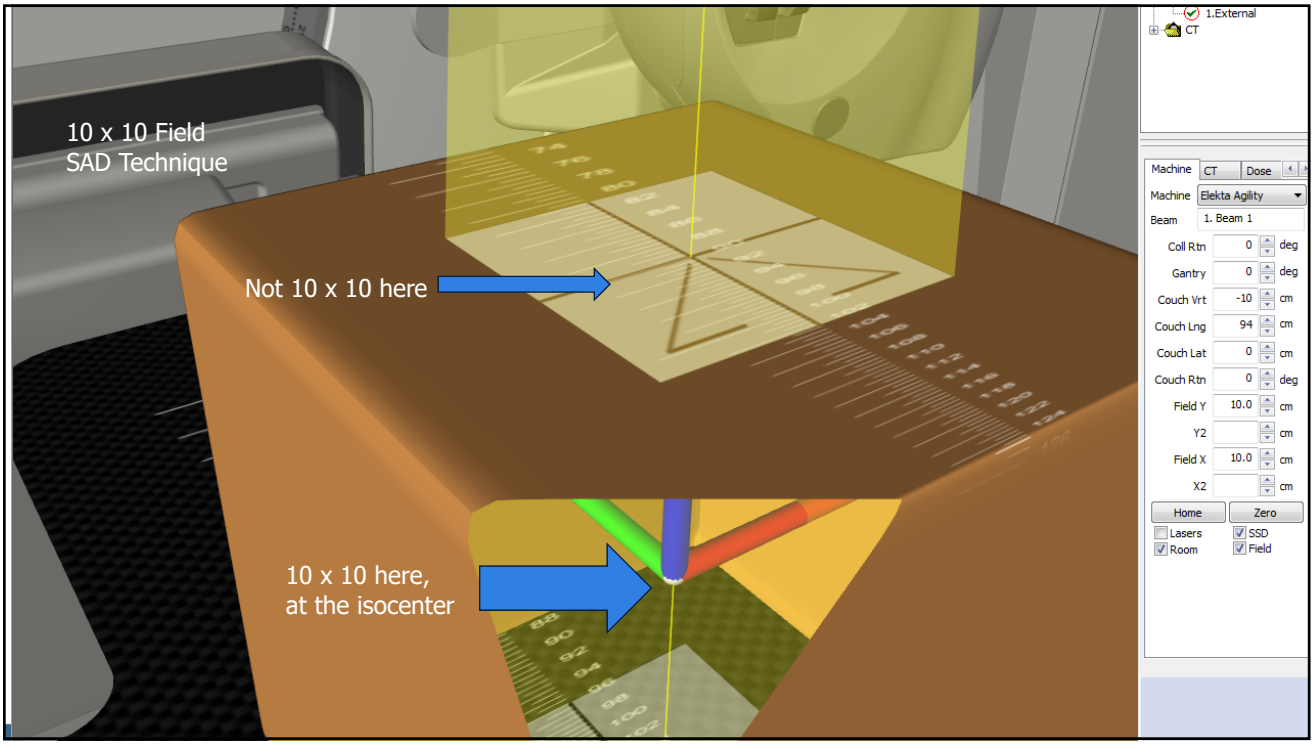
- A 100 cm treatment unit implies:

Jefferson | Philadelphia University + Thomas Jefferson University

Answer

That the collimator setting is defined at distance of 100 cm from the source of radiation.

Jefferson | Philadelphia University + Thomas Jefferson University

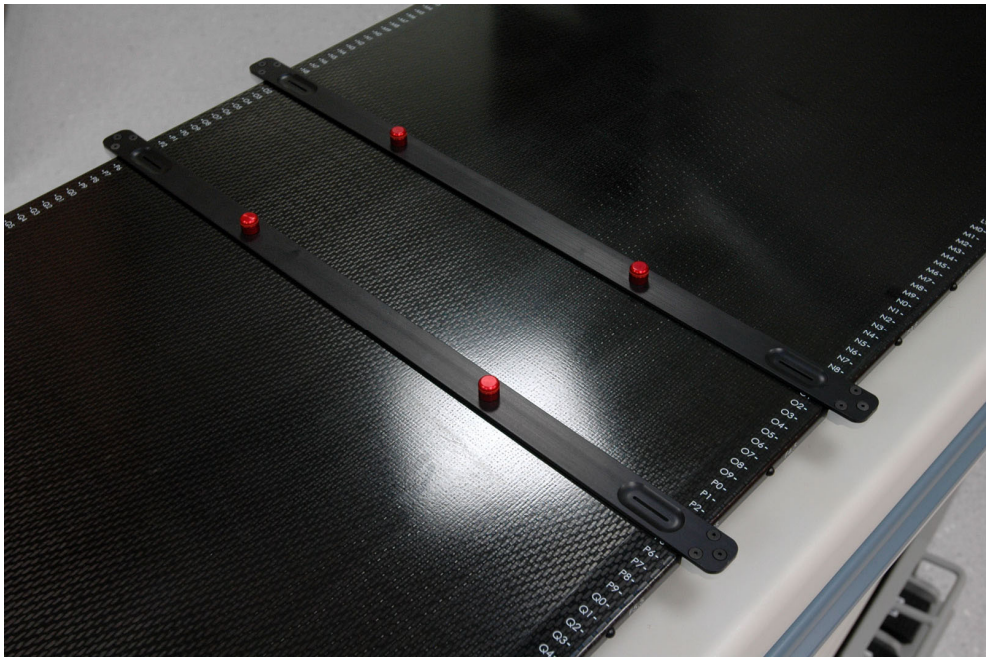


C. Treatment Machine Setup

1. Auxiliary setup devices
2. Machine Operation

1. Auxiliary Set-up devices

- Couch indexing
  - An example is affixing an immobilization device to the couch at the corresponding location from simulation
    - Uses a number and/or letter coordinate system, eg. A3
  - Increases the likelihood that reproducibility occurs
  - Can be used with vacuum bags, molded casts, head plates, belly boards etc.
  - Essential for IMRT/VMAT/SRS/SBRT



1. Auxiliary Set-up devices

- Positioning Aids and Immobilization
  - Positioning aides do not really immobilize the patient--head cups
  - Simple immobilization—partially restrict movement but require some cooperation—wing board, breast board
  - Complex immobilization—customized devices—thermoplastic masks

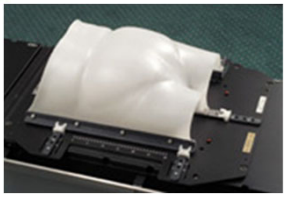
1. Auxiliary Set-up devices

- Individualized immobilization are complex and must only be used on the patient they were made for
  - Don't share bite blocks!!,
  - Some bite blocks are considered simple
  - Some are complex (vacuum bags) but can be reused after treatment completion
- Created BEFORE simulation
- Must be fit through the bore
- Must be included in the FOV

Jefferson | Philadelphia University + Thomas Jefferson University

Breast Board

Prone pillow



Hip-fix

Headrest

Belly board

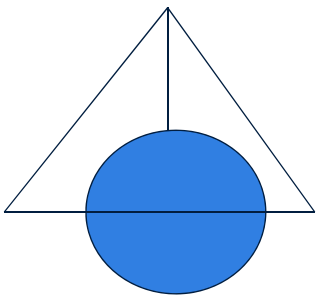
Jefferson | Philadelphia University + Thomas Jefferson University

1. Auxiliary Set-up devices

- Laser Alignment—where do lasers intersect?
  - Programmable lasers allow for exact isocenter localization in simulation
    - After the patient is scanned MD locates isocenter
    - XYZ coordinates entered into programmable lasers
    - Lasers shift to isocenter
    - Tattoo
    - Reduce initial setup time
    - Checked daily, 2mm tolerance

1. Auxiliary Set-up devices

- More on lasers
  - Used for 3 point positioning, triangulation, leveling, called many things!
  - Can damage your eyes! Don't stare into!



2. Machine Operations

- SSD and SAD
  - Using SSD to determine distance is not necessarily SSD technique
  - SSD < 100 cm = SAD or isocentric technique
  - SAD: distance from the source of the radiation axis of the beam to the isocenter
  - 100 cm – depth of iso = SSD
  - 100 cm – SSD = depth of iso
  - Depth of iso + SSD = 100 cm

Jefferson | Philadelphia University + Thomas Jefferson University

2. Machine Operations

- SSD: distance to the patient's skin from the source (or target, TSD) of the radiation
- SSD technique: placing isocenter on the patient's skin, SSD = 100 cm
- SSD is source-surface or source-skin-distance
- SAD: distance from the source of the radiation to the axis of the beam or isocenter
- SAD technique: the isocenter is at some depth within the patient on a modern linac, SSD will read less than 100 cm on the patient
- Isocentric technique

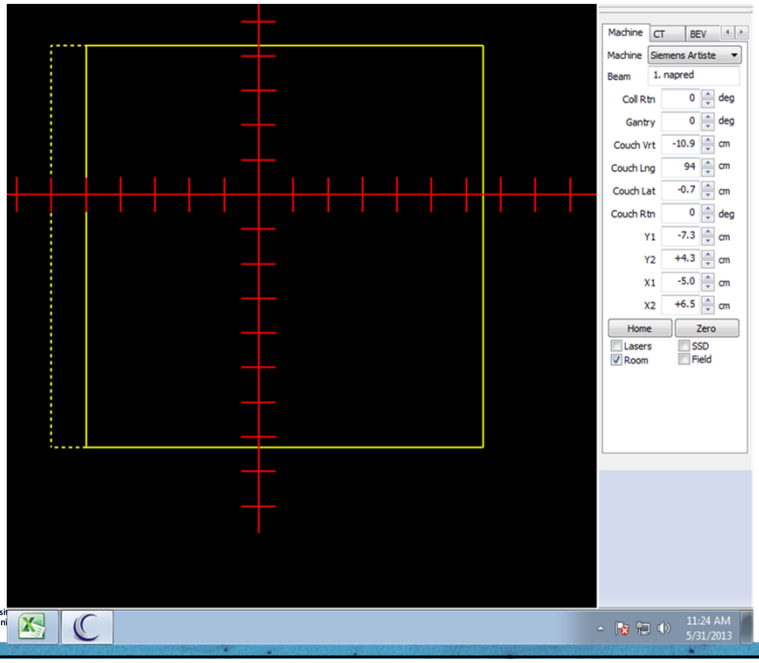
Jefferson | Philadelphia University + Thomas Jefferson University

2. Machine Operations

- SSD technique is primarily used for superficial treatments, electrons
- The advantage of SAD over SSD is you do not have to move the patient between fields
  - More accurate, single isocenter
  - Quicker treatments
- Extended distances for long or wide fields

Machine Operations

- Collimator Settings
  - Field size is often referred to as “collimator setting”
  - Width x Length
  - X by Y when collimator is at 0 degrees
  - Asymmetrical jaws

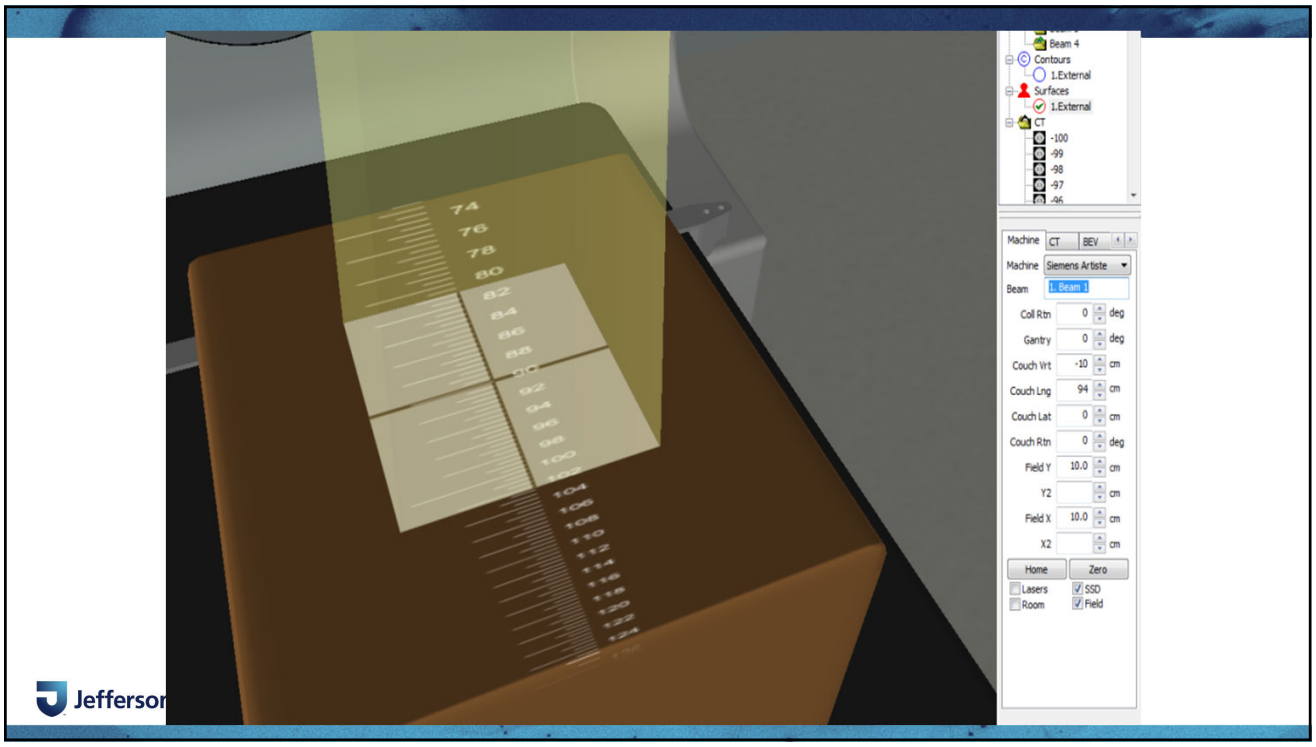


Jefferson | Philadelphia University + Thomas Jefferson University

2. Machine Operations

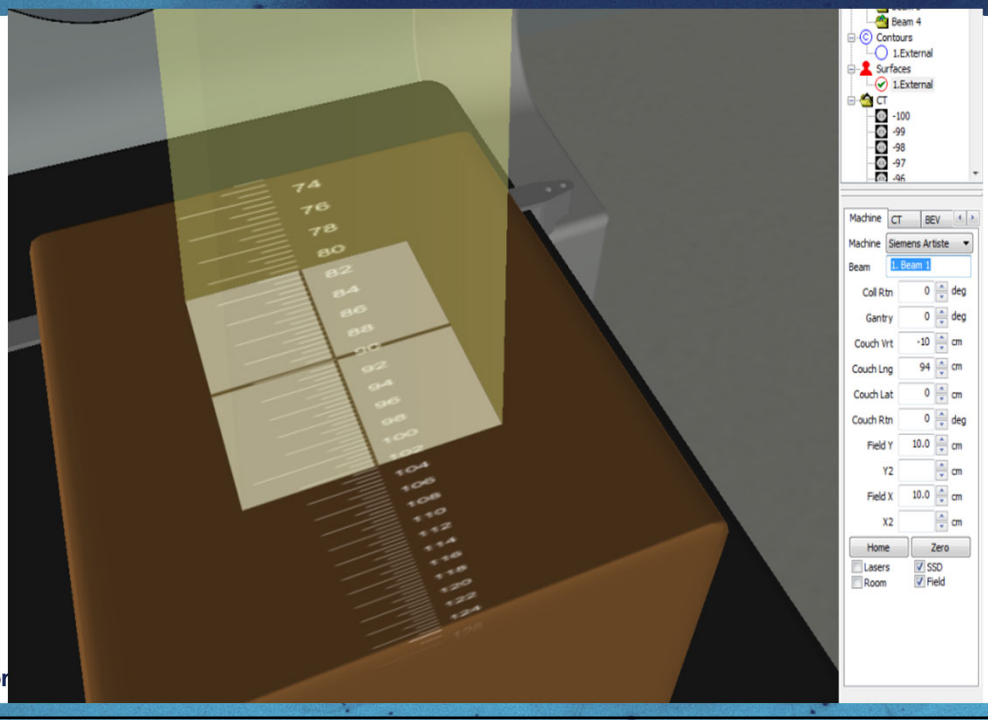
- Field Size is defined at the isocenter
  - What does this mean?
  - It means that for an isocentric technique (SAD), if the collimator settings are 10 x 10, the field that is projected on the patient's skin will be less than 10 x 10.
    - Beam divergence!

Jefferson | Philadelphia University + Thomas Jefferson University



2. Machine Operations

- Optical Distance Indicators
  - Projects the SSD on the patients skin
    - If the patient is supine and the gantry is at AP position, the SSD will decrease if the couch is raised, getting closer to the source or target
    - Rangefinder



Jefferson

2. Machine Operation

- Mechanical Distance Indicator
  - If the bulb were to burn out, can you locate the mechanical distance indicator?

rpdinc.com

Jefferson | Philadelphia University + Thomas Jefferson University

2. Machine Operation

- Gantry angle
  - Not all gantry angles are the same at different facilities, for example, 90 degrees at my clinic may be 270 degrees at yours, it just depends on how the linac is installed by the vendor
  - Gantry and collimator angle must be accurate to within 1 degree
  - Checked on monthly basis

2. Machine Operation

- Treatment couch, couch assembly, table etc.
  - Rotates about the isocenter
  - Must be the same as the simulator couch
  - Carbon fiber
  - High tensile strength
  - Some have mylar window that the patient must be positioned over as to avoid attenuation from other parts of the assembly

2. Machine Operation

- Treatment Couch
  - When adjusting the isocenter, knowledge of changes in couch direction are critical and vice versa
  - Couch left = isocenter right
  - Couch posterior = isocenter anterior
  - Are you talking patient or isocenter?
  - As with the gantry angles these are facility dependent
  - Degrees of freedom, most have 4 DOF, some have 6 DOF (pitch and roll)

2. Machine Operations

- Console controls include but may not be limited to:
  - Beam on
  - Beam off or interrupt
  - Emergency off, last resort! Machine to be reset
  - Gantry, couch, collimator controls, image receptor controls

Question

- Isocenter defined as the point:
  - I. At the center of the tumor mass
  - II. That the gantry rotates around
  - III. That the collimator rotates around
  - IV. Where all the lasers meet

  - A. I only
  - B. I and II only
  - C. II, III, and IV only
  - D. I,II,III and IV

Answer

c. II, III, and IV only

Jefferson | Philadelphia University + Thomas Jefferson University

Question

- The optical distance indicator has burned out on the gantry. Explain how we can determine that our SSD is correct?

Answer

- Mechanical distance indicator
- Laser intersection

Jefferson | Philadelphia University + Thomas Jefferson University

Question

- A patient begins coughing while the beam is on. You should:
  a) Finish the beam and check patient position
  b) Push the red emergency off
  c) Turn beam off by turning the key or beam interrupt
  d) Turn the cameras off
  e) B and C

Jefferson | Philadelphia University + Thomas Jefferson University

Answer

- Turn beam off by turning the key or beam interrupt

Jefferson | Philadelphia University + Thomas Jefferson University

Key Points

- Position treatment machine and accessory equipment to reproduce set-up indicated by approved treatment plan and initial CT/Simulation
- **REPRODCUCIBILITY**

Question

A patient's IFD (separation) is 22 cm in the AP/PA projection. An anterior SSD of 92 cm is measured with a 100 cm SAD treatment plan. The PA SSD should be:

A. 114 cm
B. 78 cm
C. 86 cm
D. 108 cm

Jefferson | Philadelphia University + Thomas Jefferson University

Answer

- C: 86 cm

Jefferson | Philadelphia University + Thomas Jefferson University

Question

- When checking positioning lasers they must be accurate within:

A. 1 mm
B. 2 mm
C. 3 mm
D. 4 mm

Jefferson | Philadelphia University + Thomas Jefferson University

Answer

- B: 2mm

Jefferson | Philadelphia University + Thomas Jefferson University

Question

- The door interlock must be checked
  A. daily
  B. weekly
  C. monthly
  D. yearly
  E. Whenever the Phillies win

Jefferson | Philadelphia University + Thomas Jefferson University

Answer

- daily

Jefferson | Philadelphia University + Thomas Jefferson University

Possible Question

- An alpha cradle or vac lok is made:
  a. before simulation scan
  b. immediately after simulation scan
  c. the day of verification films
  d. depends on the physician

Jefferson | Philadelphia University + Thomas Jefferson University

Answer

- a. before the scan

Jefferson | Philadelphia University + Thomas Jefferson University

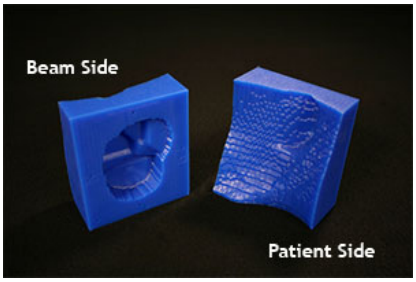
D. Treatment Accessories

1. Beam Modifiers
2. Immobilization devices (covered in section C)
3. Parameters

Jefferson | Philadelphia University + Thomas Jefferson University

1. Beam modifiers

- Compensators
  - Used for the same purpose of wedges
  - Account for different contours of patient's anatomy
  - Different in that they are customized to each patient



dotdecimal.com

1. Beam modifiers

- Shielding
  - Used to shape the beam and spare normal tissue
  - Blocks replaced by MLCs
    - Not completely, island blocking
    - Negative shielding: when the beam travels through the hole in the block; electron cutouts, photon blocks
    - Positive shielding: when the block is solid and blocks a structure; cord block, lung and kidney blocks for TBI
    - MLCs designed to keep minimize leakage

1. Beam Modifiers

- Some key points about blocks
  - Must reduce the transmission of the beam to less than 5%
  - Divergent blocks reduce penumbra
  - BLT with Cheese
    - Bismuth, lead, tin, cadmium (cadmium is toxic)
  - Advantage over lead, lower melting point
  - More Cerrobend required, not as dense as lead
    - Cerrobend to lead ratio 1.21:1 x the HVL required
  - e- cutout thickness = energy/3
  - HVL

Jefferson | Philadelphia University + Thomas Jefferson University

1. Beam Modifiers

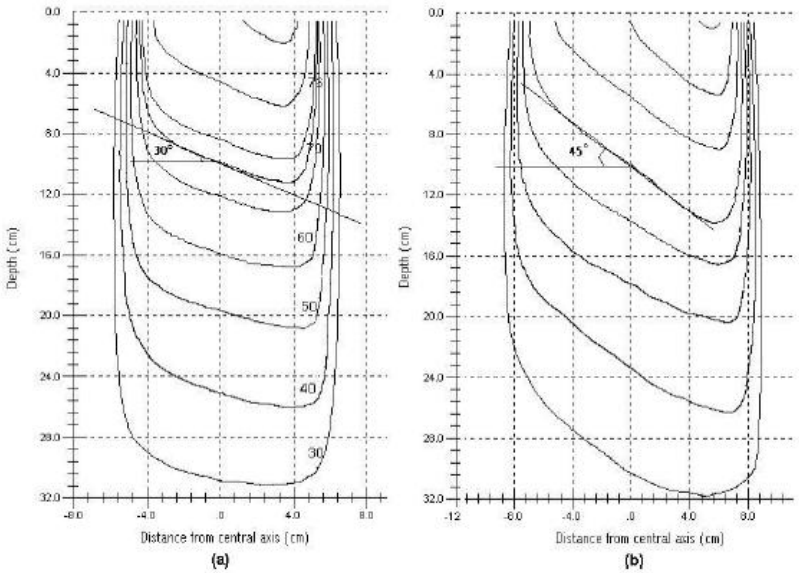
- Bolus
  - Superflab
  - Water
  - Rice bags
  - Wet gauze
  - Superstuff
- Bring dose closer to the surface
- "fakes out" the beam
- **Decreases skin sparing**
- Same density as tissue
- Skin reactions
- Avoid air gaps

Jefferson | Philadelphia University + Thomas Jefferson University

1. Beam Modifiers

- Wedges
  - Change the shape (or tilt) of the isodose curves to avoid critical structures and compensate for uneven patient surfaces/thickness
  - Physical wedges come in different angles
    - 15, 30, 45, 60
  - Be able to recognize where the heel and toe are positioned by looking at an isodose curve….for example, where is the heel and toe of the wedge in the next slide?

Jefferson | Philadelphia University + Thomas Jefferson University



Jefferson | Philadelphia University + Thomas Jefferson University

jacmp.org

1. Beam Modifiers

- Used on sloping surfaces
  - Breast
  - Lungs
  - Neck
  - Others too, depends on patients body habitus
- Wedges do not affect beam energy

1. Beam Modifiers

- Dynamic wedges
  - Upper collimator moves across the field as the beam is on
  - Creates a wedge affect
  - Decreases treatment time

Key Points

- Correctly place wedges, compensators, or blocks according to plan
- Wedges 15, 30, 45 and 60 degrees typically
- Dynamic Wedges
- Deliver treatment by setting and activating controls on console
- Monitor patient visually and by intercom system during treatment
- Report any treatment errors!

Question

- Which of the following is an advantage to using cerrobend blocks vs. lead blocks?
  - A. Has a lower melting point than Pb
  - B. Is heavier than Pb
  - C. Has an equivalent thickness to lead
  - D. Is softer than lead

Jefferson | Philadelphia University + Thomas Jefferson University

Answer

- A: Has a lower melting point than Pb

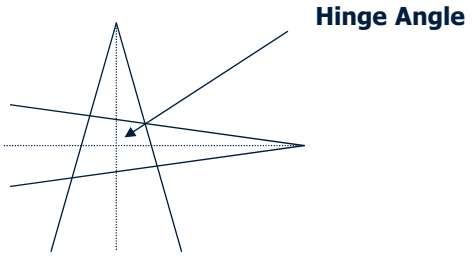
Question

- The hinge angle is:

A. The angle of the central axis and 50% isodose line
B. The angle created between the central axes of 2 wedged beams
C. The angle that the central axis makes with a 30 degree wedge
D. None of the above

Answer

- B: angle between the central axes of 2 wedged beams



Question

- Two wedged fields create a 90 degree hinge angle. What is the wedge angle?
  A. 180 degrees
  B. 60 degrees
  C. 30 degrees
  D. 45 degrees

Answer

- D (45 degrees)
  - 180-HA/2
  - 180-90=90
  - 90/2=45

Question

- The physician prescribes an electron treatment with 0.5 cm of bolus. She specifies that she wants the SSD to be 100 cm at the skin. What should the SSD read on the bolus?

A. 95 cm
B. 100.5 cm
C. 99.5 cm
D. No enough information provided

Answer

C. 99.5 cm

Jefferson | Philadelphia University + Thomas Jefferson University

2. Immobilization Devices
3. Parameters

- Covered in previous slides

Jefferson | Philadelphia University + Thomas Jefferson University

E. Treatment Administration

1) Monitoring Systems
2) R&V Systems
3) Image Acquisition and Registration
4) Site Verification
5) Dose Verification
6) Equipment malfunctions

1. Monitoring Systems

- Direct, windows
- Indirect
  - Cameras, must have 2 cameras, why 2?
  - Mirrors
- Audio, two way communication systems
- Emergency situations
  - Always beam off first. Turn key if applicable
  - Open the door, should deactivate beam
  - Emergency breaker
  - Always remove patient from the beam first

1. Patient Monitoring

4 Reasons to
Monitor the Patient

- Patient safety
- Accuracy of treatment
- Pt. motion
- Prevent Collision

2. Record and Verify Systems

- Varian=Aria and Mosaic
- Elekta=Mosaic

2. Record and Verify

- Ensures that actual parameters agree with planned parameters
- Does not eliminate error!
  - Eg., treating 2 sites with similar parameters!
- Parameters include
  - Gantry, collimator, couch angles, MUs, couch parameters, etc

2. Record and Verify

- Have mostly replaced the paper chart
- Your login is the same as you signing the chart
- The chart is a legal document
  - If it is not documented……
- Contains all the elements of a paper chart including
  - Fx
  - Elapsed days
  - Daily dose
  - Total dose
- Records everything that was done

3. Image Acquisition and Registration

- Images are acquired at simulation
- Images transferred to planning system
- Isocenter determined in relation to x, y, z coordinates
- Subsequent images on the treatment are fused or compared. The difference in position from the isocenter with regard to x, y, and z are determined and necessary adjustments are made or registered:
  - Rigid body registration
- A more complicated method that accounts for changes in soft tissue is:
  - Deformable registration

3. Image Acquisition and Registration

- IGRT
  - Correct Isocenter
  - Treatment field check
  - Changes made to field
  - Documentation of treatment
  - Identification and orientation of field

3. Image Acquisition and Registration

- IGRT
  - Being used often today
    - Small fields demand small tolerances
    - kV/kV imaging, cone beam CT, ultrasound, fiducials
    - Can be done daily, weekly, on specific days

4. Site Verification

- Done on first day
- Should be done at least once a week

5. Dose Verification

- Diodes, mosfits—record dose delivered

***Interrupt beam if dose continues to rise above expected value

IMRT: QA on phantom pre tx.

6. Equipment Malfunctions

- Electrical, Mechanical, Radiation
- Report any equipment malfunctions or setup errors to the radiation oncologist and physicist
- Written report of corrective action must be made
- Errors resulting in misadministration must be reported to the NRC or state reporting requirements

6. Equipment Malfunctions

- Malfunctions causing death or serious injury are reported through the U.S. FDA's Medical Device Reporting Act
- Statutory Errors
  - Required by law
  - May depend on magnitude and error type
  - Some are automatically required to report
- Voluntary
  - ROSIS
    - Rad. Onc. Safety Info. System
  - International reporting data base
  - ROILS
    - Rad. Onc. Incident Learning System; ASTRO, AAPM

Jefferson | Philadelphia University + Thomas Jefferson University

Medical Event

- an event is any incident that is not consistent with the ordinary course or expected outcomes of operations involving the use of radioactive materials or radiation producing equipment. An injury does not have to occur. Events include, but are not limited to: physical harm to patients or third parties such as visitors, equipment malfunctions that could potentially cause unexpected radiation exposures to patients or employees, unsafe radiological situations or working conditions, violations of the license or registration conditions, loss of radioactive material or events in which a dose is delivered to the patient that is not in accordance with the prescribed treatment plan (plan as prescribed prior to start of treatment).

Jefferson | Philadelphia University + Thomas Jefferson University

Charge Capture

- Professional and technical components
- CPT principles
  - Current procedural terminology

Jefferson | Philadelphia University + Thomas Jefferson University

Key Points

- Verify fields by taking and DOCUMENTING PFs
- Send to MD for review
- Document any changes

Jefferson | Philadelphia University + Thomas Jefferson University

Key Points

- Monitor treatment machine console and report any errors
- Track doses and alert physics and oncologist for over or under-doses
- Document and sign each chart after each treatment

RT Procedures Are Cross-Checked

- Transfer of treatment parameters from planning system to R&V system by dosimetry
- Double check of the treatment plan by physics
- ID of patient, name, photo, birth date
- Verification of treatment set-up
- MD review and approval of all portal images for all fields BEFORE treatment
- Weekly check films reviewed by therapist and MD
- Final chart check after completion of treatment
- Daily prescription check

Unretracted Cobalt Source

- Remove patient from treatment area
- Close collimator/retract source
- Record time of failure

Question

- True or false: A record and verify computer based program can identify set-up errors prior to treatment?

Jefferson | Philadelphia University + Thomas Jefferson University

Answer

- True, but not all errors!

Question

- Which of the following is direct observation:
  - A) lead glass window
  - B) closed circuit camera
  - C) intercom
  - D) all of the above

Jefferson | Philadelphia University + Thomas Jefferson University

Answer

- A: lead glass window

Jefferson | Philadelphia University + Thomas Jefferson University

Question

- 4D gated treatments are designed to account for:

A. Intrafraction motion
B. Interfraction motion
C. Inaccuracies of the setup
D. All of the above

Jefferson | Philadelphia University + Thomas Jefferson University

Answer

A. Intrafraction motion

Question

- One way to ensure that radiation beams are irradiating the pre-determined volume is by:
  - A) kV/kV imaging
  - B) Taking port films
  - C) Using diodes
  - D) Fluoroscopy

Answer

- B: while kV imaging is useful for adjusting for inter-fraction movement, it does show what exactly will be radiated

Question

- While treating a patient using a rotational technique, the gantry rotates past the end point. The is most likely a malfunction of the:
  - A) Console
  - B) Limit Switch
  - C) Collision Ring
  - D) Override Switch

Answer

- B: Limit Switch

Question

- Which of the following interlocks will terminate all power to a linear accelerator?
  - I. Beam off button
  - II. “Emergency off” button
  - III. Red “panic” button in treatment room
  - IV. Main circuit breaker

  - A) I, II and III only
  - B) I, II and IV only
  - C) I, III and IV only
  - D) II, III and IV only

Answer

- D:II, III and IV only

Question

- A patient begins treatment on a Thursday, after the following Tuesday's treatment what will the elapsed days read? Assuming the 1rst elapsed day is 0.
  - A) 4
  - B) 5
  - C) 6
  - D) 7

Answer

- B:5

Jefferson | Philadelphia University + Thomas Jefferson University

MR-guided-Radiation Therapy—Board Items

- MRI Screening
  - THE MOST IMPORTANT ASPECT
  - Must be done for ALL patients prior to entering the room EACH time
  - Staff must be screened annually & update screening form as appropriate

Jefferson | Philadelphia University + Thomas Jefferson University

Biomedical implants

- Essentially, any device that is placed within the body and left there
  - Pacemakers
  - Joint replacements
  - Stent/shunt
  - Pump (insulin, morphine, chemo)

**May be safe or unsafe to enter the MRI room. If safe, may have conditions, or cause artifact on image if in the FOV

Ferrous foreign bodies

- Any type of magnetic item that when placed in a magnetic field, can cause tissue warming & damage; or move, potentially causing injury or death
  - Shrapnel/Bullet fragments
  - Metal shavings (typically in the eye) from metal work
  - Kids who eat or insert things they shouldn't! (batteries)

Medical Conditions

- Pregnancy: considered safe for mother and baby in all trimesters

Fun fact of the day: the reason why pregnant people get ultrasounds and not MRIs, is that in an MRI, this is what a fetus looks like.

Jefferson | Philadelphia University + Thomas Jefferson University

Medical Conditions

- Seizure Disorders: repetitive acoustic patterns have been shown to cause seizures. Important for the technologist to interrupt the scans, check in with patient frequently
- Claustrophobia: Xanax & Ativan are very helpful with making patients more comfortable and able to tolerate the procedure
  - Other options: mirrored glasses, music, feet first v. head first

Jefferson | Philadelphia University + Thomas Jefferson University

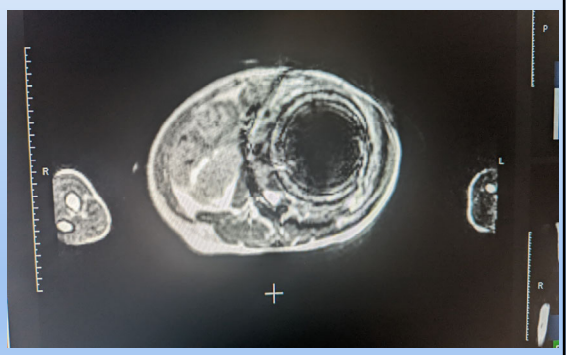
Prior Diagnostic Scans

- Since MRI offers better soft tissue contrast than other modalities, patients will often get several types of scans to aid in diagnosis
  - Typically, these scans compliment each other and are able to be fused together
  - Having the ability to look at previous scans can also aid in checking the area for implants/foreign bodies (taking into consideration any procedures that may have been done in the elapsed time)

Jefferson | Philadelphia University + Thomas Jefferson University

Surgical Procedures

- Very important to know what procedures the patient has had in the past. Often, patients will have surgical clips or implanted devices that they forget about or are unaware of
  - Biggest take away: What kind of surgery? Can we find the records? Was anything implanted?



Jefferson | Philadelphia University + Thomas Jefferson University

Topical or Externally Applied items

- Tattoos: some ink may contain some trace amounts of ferrous alloys—can cause burning! Remind pt. to let the tech. know immediately if burning occurs, terminate scan.
- Body Piercing/Jewelry: remove it! May contain multiple alloys, some of which may be ferrous. Can cause heating & burns
- Medication patches
  - Several patches contain trace amounts of various alloys in their backing
    - Have been shown to cause burns on patients
    - If it can be removed, remove it.

Jefferson | Philadelphia University + Thomas Jefferson University

Ancillary Equipment

- ALL equipment MUST be MRI safe to enter the room
  - Wheelchairs, stretchers, IV pole, oxygen tank, fire extinguisher
  - If not MRI safe and brought into vault, can result in injury & death

Jefferson | Philadelphia University + Thomas Jefferson University

Jefferson
Philadelphia University +
Thomas Jefferson University

Good Luck!

Thank you for attending!