

Types of RT Protection Methods in Head and Neck Cancer Patients

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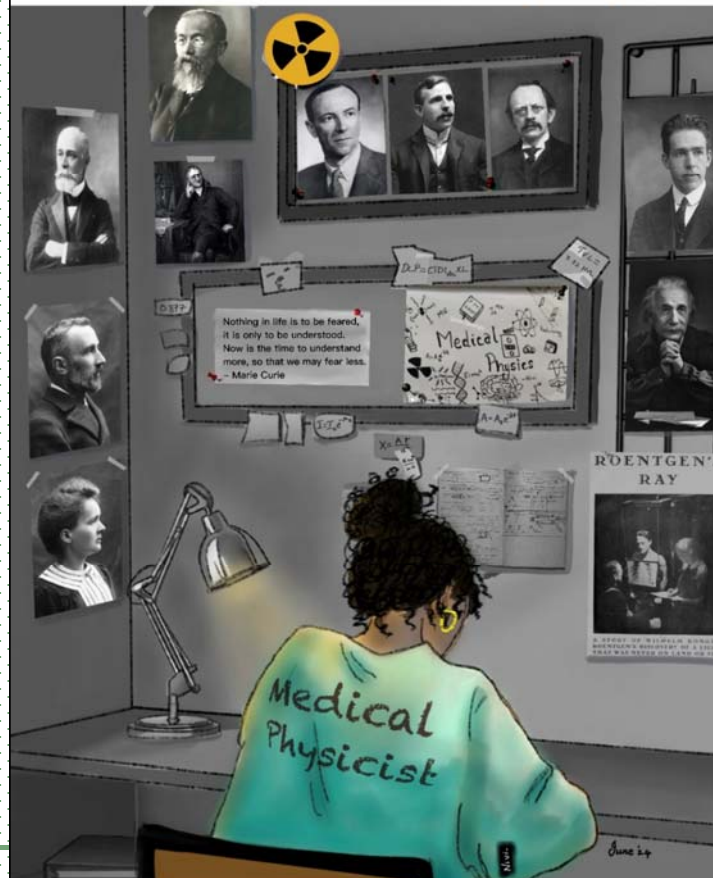
Tabriz University of Medical Sciences

International Organization for Medical Physics



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Contents:

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1. H&N cancer

Causes of H&N cancer

1. The use of **tobacco and alcoholic** beverages is the most common cause of **mouth, throat, larynx and tongue cancers**.
2. In adults who do not use cigarettes and alcoholic beverages, the **Human papilloma virus (HPV)** can cause **throat cancer**.
3. Also, **prolonged exposure to sunlight** can cause **lip and skin cancer**.



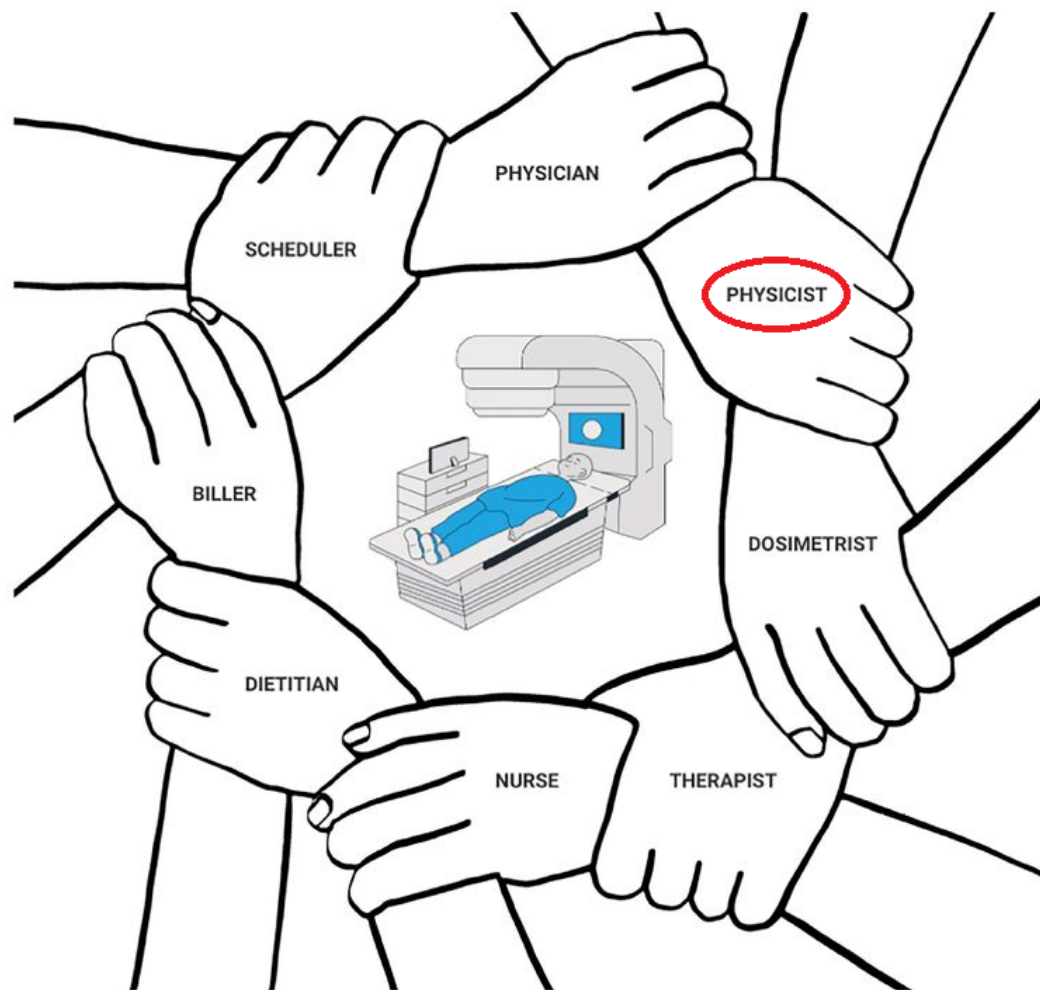
7 early signs of H&N cancer

1. Cervical lumps
2. Voice change
3. Oral gland
4. Raising blood
5. Swallowing problems
6. Skin changes
7. Persistent earache





2. Roles (RO, RT, MP)



Roles (RO, RT, MP)

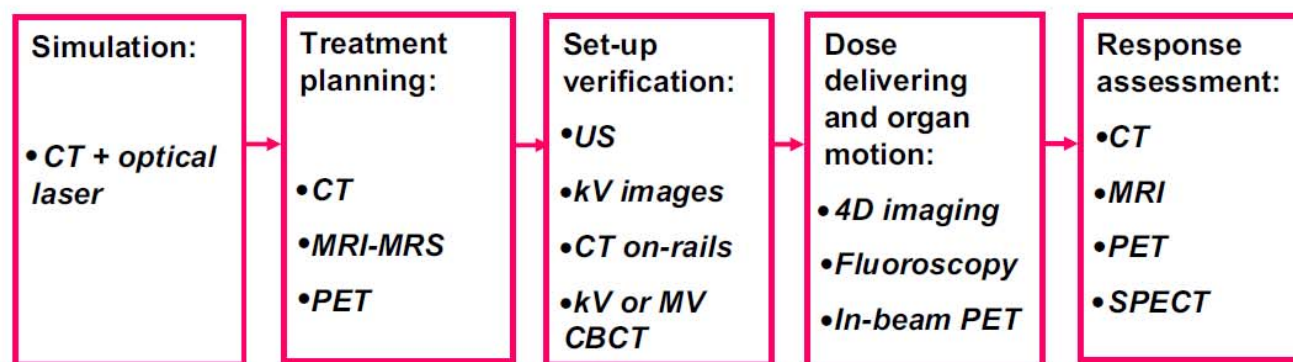
		Roles
Radiation Oncologist	RO	Advice about treatment options and consent for treatment Target and normal tissue delineation Prescription of radiotherapy Planning review and approval Monitoring of treatment Patient follow-up
Radiation Therapist	RT	Patient information and support Simulation Planning Producing and checking treatment plans Data transfer and monitor unit calculations Daily radiotherapy delivery Treatment verification Monitoring the patient on a daily basis
Medical Physicist	MP	Specification of equipment used in therapy and imaging Facility design, including shielding calculations Commissioning of diagnostic, planning and treatment equipment and software Dosimetry assurance Quality assurance of diagnostic, planning and treatment equipment and software



3. Roles (Imaging)

Roles (Imaging)

The 5 phases of the high-precision RT process:



Schematic view of the imaging modalities used or now investigated in the high-precision RT process (*CT* computed tomography, *MRI* magnetic resonance imaging, *MRS* magnetic resonance

spectroscopy, *US* ultrasonography, *kV* kilovoltage, *MV* megavoltage, *CBCT* cone beam CT)

What Radiologists Should Know

In medical imaging, CT artifacts can be a common challenge, yet understanding them is crucial for accurate diagnosis, making it essential for radiologists to recognize and understand them.

Artifacts are distortions or errors in the imaging data, leading to misleading images. Recognizing and mitigating these artifacts is essential for ensuring the best patient care.

one

Beam Hardening

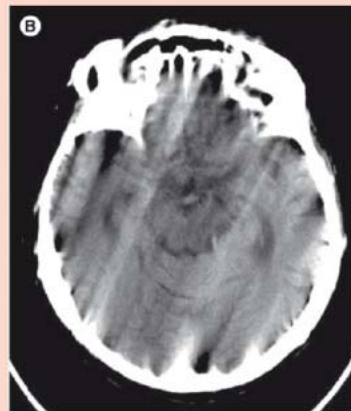
This results in streaks or dark bands, particularly around dense structures like bone. It occurs because lower-energy X-rays are absorbed more than higher-energy ones.



two

Motion Artifacts

These occur when a patient moves during the scan, leading to blurring or ghosting of the image.



three

Metal Artifacts

Seen as streaks or starburst patterns, these are caused by the presence of metal objects within the body, such as dental fillings or surgical implants.



Four

Ring Artifacts

These appear as concentric rings in the image, often caused by detector malfunctions or calibration errors.



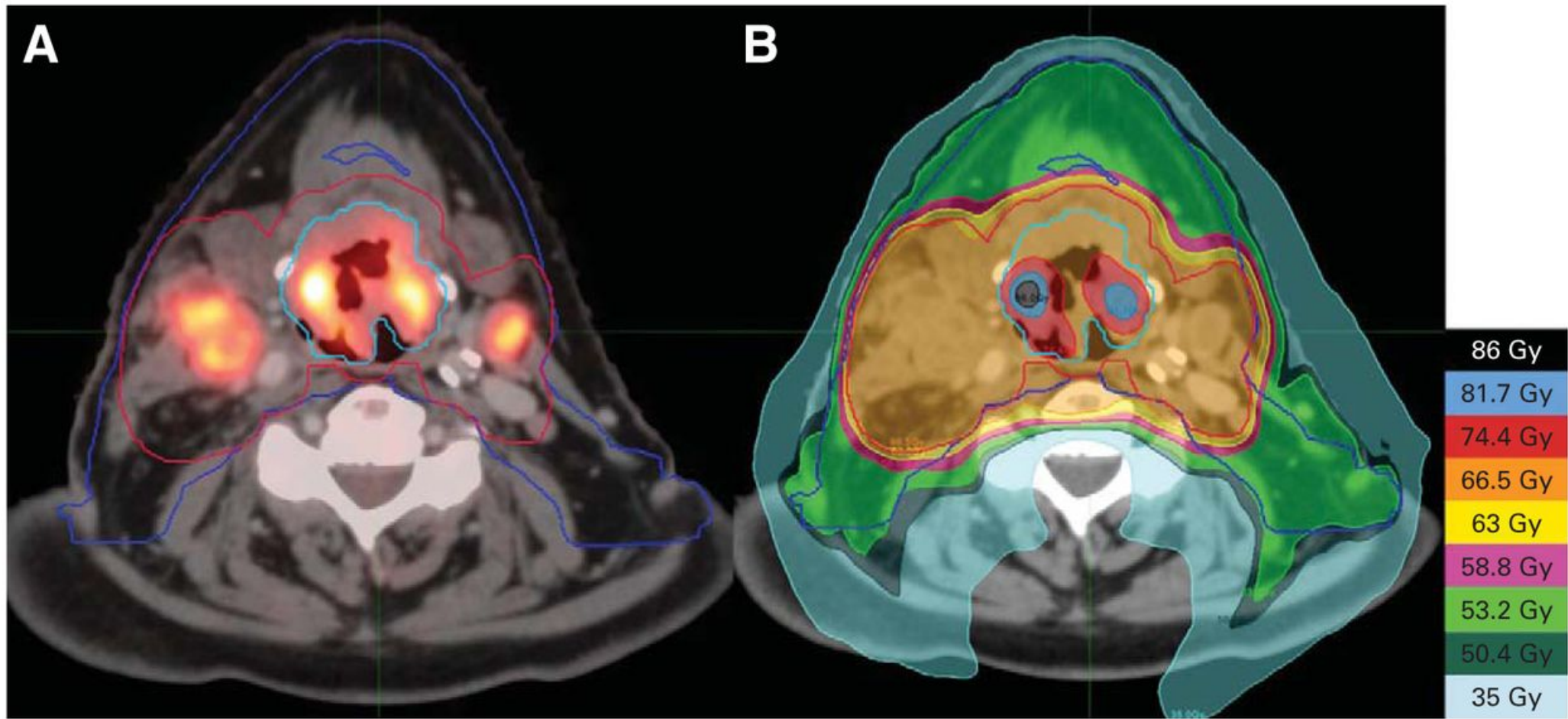
Partial Volume Artifacts

Five

occurs when tissues of widely different absorption are encompassed on the same CT voxel producing a beam attenuation proportional to the average value of these tissues.



Roles (Imaging)





4. Protection in RT

Protection in RT

Radiation effects

Deterministic effects:

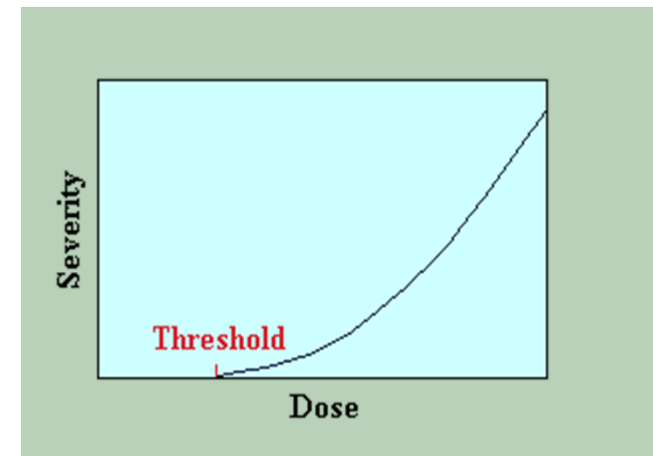
There exists a certain level, the “Threshold”, below which the effect will be absent.

Example: Cataract, Erythema, Infertility, etc.

Stochastic effects

Severity of effects on human beings, increase with increasing doses (Without “threshold”)

Example: Cancer, Genetic effects, etc.



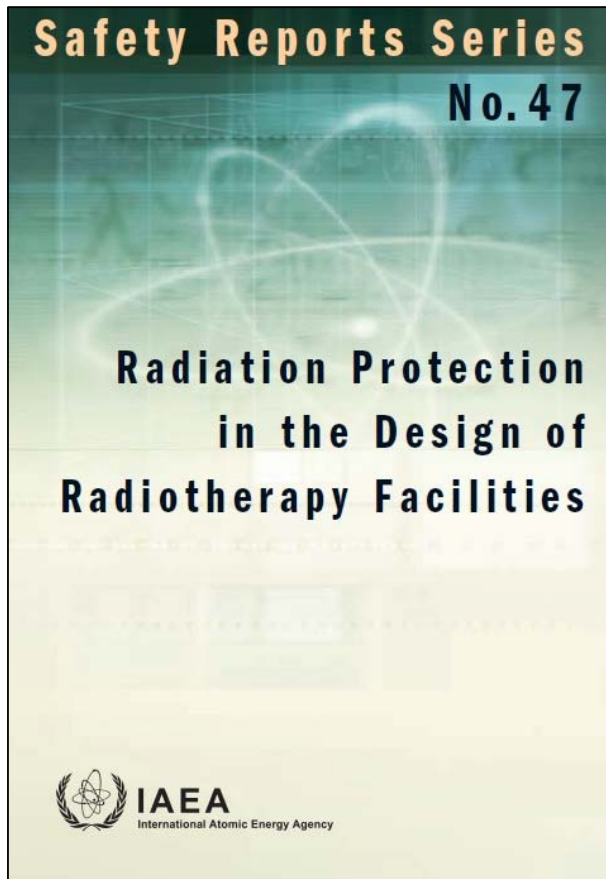
Protection in RT

اثرات حاد: تهوع - کسالت - بالا رفتن دما - تغییرات خونی

از ۲۵۰ تا ۵۰۰ میلی گری به بالا: تغییر در CBC
بعد از ۲ گری: سندروم خون سازی، کاهش یا قطع فعالیت مغز استخوان
از ۱۰ گری به بالا: سندروم معده ای - روده ای
از ۲۰ گری به بالا: سندروم دستگاه عصبی، بیهوشی و مرگ ظرف چند ساعت

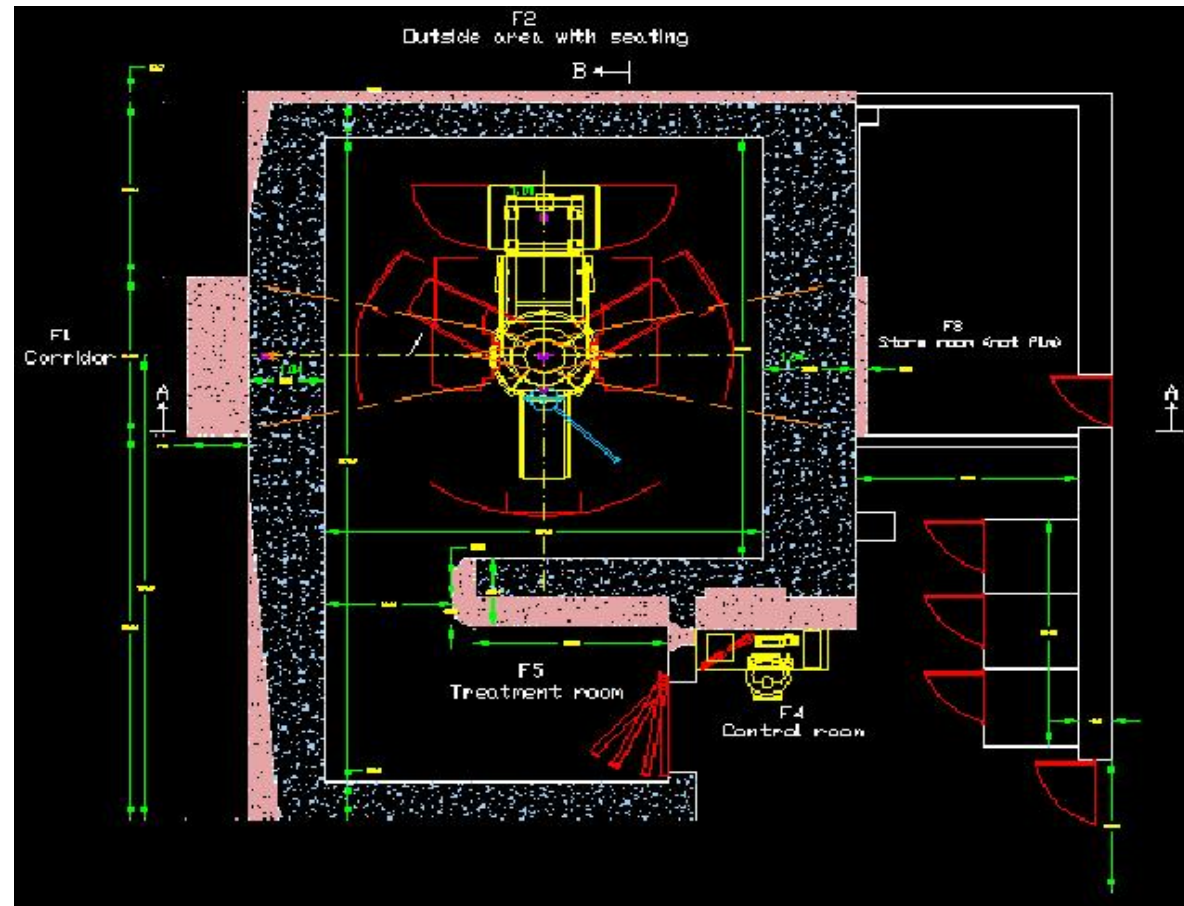
اثرات مزمن و تاخیری:
از ۱ گری به بالا: سرطان (خون) در طول ۵ تا ۲۰ سال
کوتاهی عمر و یا آب مروارید

Protection in RT



Protection in RT

An example



Protection in RT

Ozone- Siemens standards

26 Room Planning 5

Environmental Requirements

Air Conditioning
Maintain room temperature between 40°F and 70°F.

Treatment Room Ventilation
The treatment room must be adequately ventilated during operation. The exhaust system must be capable of about 10 exchanges of room volume per hour, depending on the room volume. The system must comply with ASHRAE 62.1-2009 and observe DIN 1946-4.

Ozone Production
The system produces a very small amount of ozone during operation, <10 parts per billion per hour during continuous operation, with room volume of 130 m³. There are no special ventilation requirements caused by ozone generation.

NOTE
It is important to adhere to the local authorities's health requirements for standard ventilation of treatment rooms in hospitals.

Flooring
Static dissipative or antistatic floor covering in control area. Materials used must be tested and approved by the manufacturer. Ω measured per ANSI/ESD S7.1-2007.

Radiation Shielding Specifications
Siemens is not responsible for shielding design. The shielding must be subject to specification and approval by a qualified radiation expert. Use an average X-ray transmission factor (MLC), in performing calculations. Special shielding requirements must be observed.

Ozone
Energies up to 21 MeV are produced by the MEVATRON electron beam. Interaction of the beam and air produces ozone and isotopes of nitrogen. The recommended maximum permissible concentration of these gases is 0.1 parts per million (ppm) for ozone, and 5 ppm for isotope N3 of nitrogen. The treatment room must be adequately ventilated at all times. An exhaust blower must be used during operation of the linear accelerator, and the exhaust system must be capable of about 10 exchanges of room volume per hour. Refer to *National Council on Radiation Protection and Measurements (NCRP) Reports 49, 51, and 57.*

WARNING: LASER BEAMS
Damage to the retina of the eye can result from looking directly into a laser beam or into a reflection of it from a polished surface. The protective housing of the laser units must not be removed by the operator.

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If ozone can be smelled, its concentration is too high. Stop the electron mode and the operation of the machine.

Protection in RT

Ozone- IAEA standards

RADIATION PROTECTION AND SAFETY IN RADIO THERAPY

replacing ordinary concrete with other materials will have serious financial implications; for example, high density concrete (5 g/cm^3) will cut the barrier thickness roughly to half of that required for ordinary concrete, but on a per volume basis the costs of the shielding material will increase by a factor of 30. The difference is even more pronounced when steel or lead is used for

A similar problem is posed by the direct activation of elements in (x, n) reactions, such as ^{15}O (half-life 2 minutes) and ^{13}N (half-life 10 minutes). The radioactivity in treatment room air is removed by efficient room ventilation. The ventilation also handles the removal of ozone and noxious gases, in addition to the removal of radioactive gases, through 6–8 air exchanges per hour.

dose:

Neutrons can activate other elements, which remain radioactive and will contribute to the radiation exposure of radiotherapy staff entering the treatment room after a high energy photon beam treatment. The radionuclides from activated components of a linac are generally short lived (of the order of seconds to a few minutes).

A similar problem is posed by the direct activation of elements in (x, n) reactions, such as ^{15}O (half-life 2 minutes) and ^{13}N (half-life 10 minutes). The radioactivity in treatment room air is removed by efficient room ventilation. The ventilation also handles the removal of ozone and noxious gases, in addition to the removal of radioactive gases, through 6–8 air exchanges per hour.

The concrete primary and secondary barriers designed to protect against photon dose are quite adequate to protect against electrons and contamination neutrons. However, neutrons undergoing multiple scattering along the maze can present an unacceptable radiation level in the control area, thus requiring a specially designed door.

16.18.7. Door of a linac room

The door of a high energy linac installation may require shielding against X rays and neutrons scattered through the maze towards the linac control area. High energy neutrons are more of a problem than low energy photons.

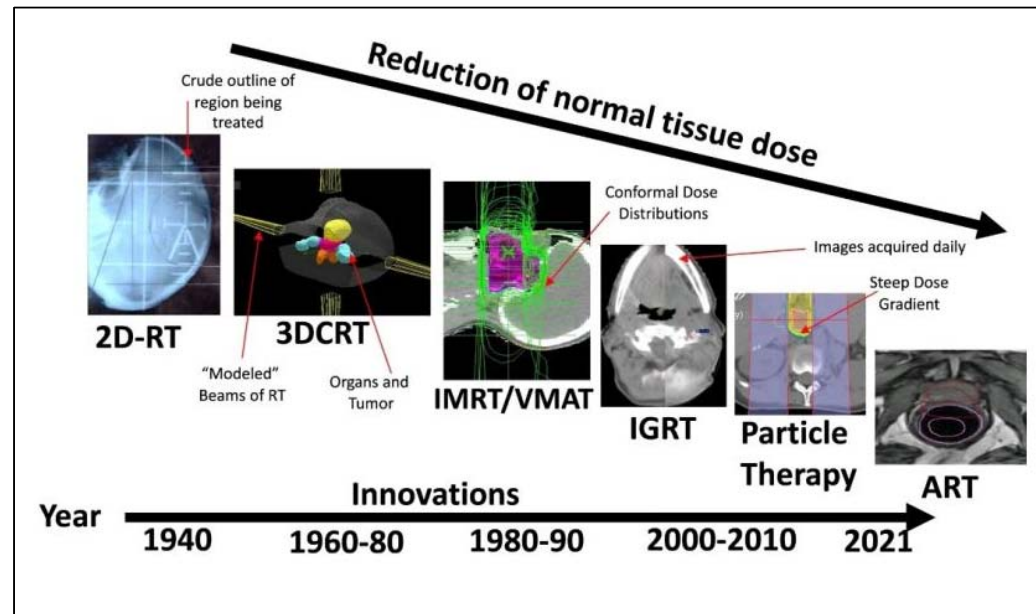
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5. Types of RT methods

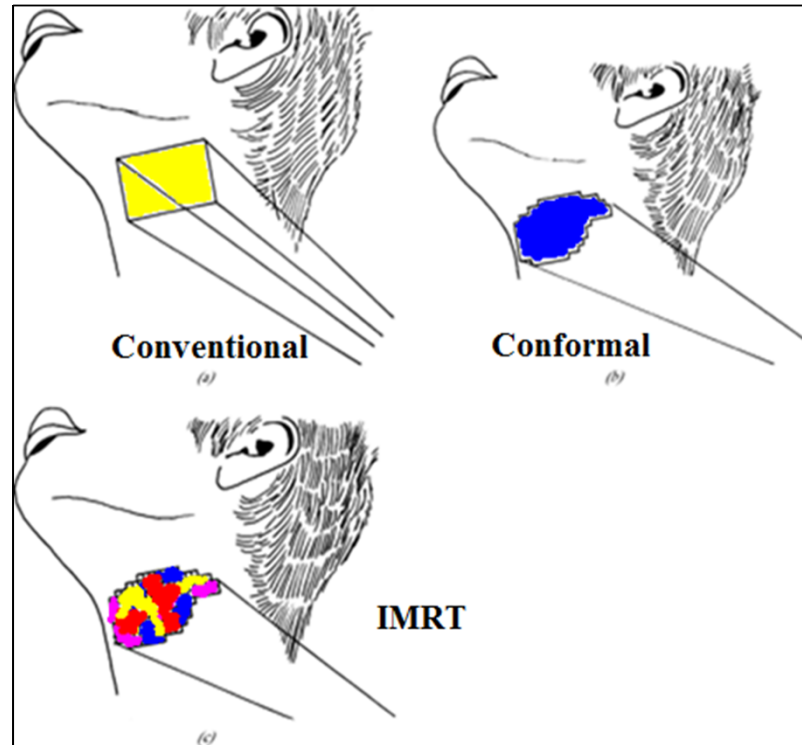
Types of RT methods

The Evolution of Radiation Therapy

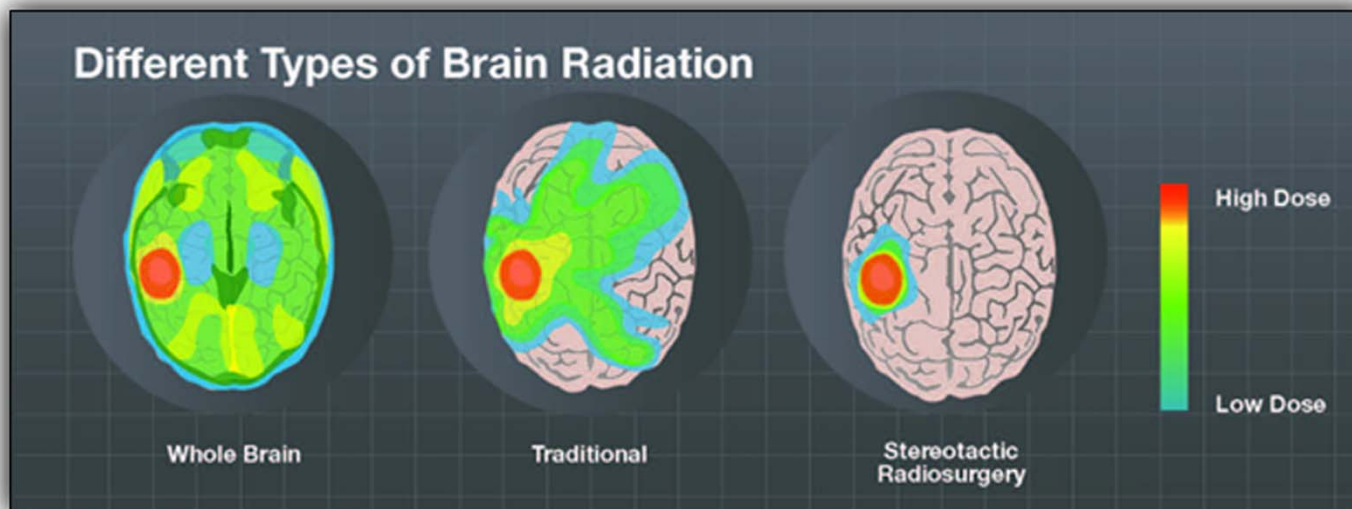


➡ **Max** dose to the **target**, **Min** dose to the **healthy tissues**.

Types of RT methods



Types of RT methods



جدول ۱. محدوده انرژی فوتون مناسب برای درمان ارگان‌های مبتلا به سرطان.

ارگان درگیر	^{60}Co	۴MV	۶ MV	۱۰-۱۵MV	> ۱۸ MV
مغز	←→				
سر و گردن	←→				
پستان	←→				
ریه		←→			
غدد لنفاوی		←→			
لوزالمعده			←→		
روده و معده			←→		
مثانه			←→		
کولون و رکتوم			←→		
اطفال		←→			
دستگاه تناسلی زنانه		←→			
دستگاه تناسلی مردانه			←→		
دستگاه عصبی مرکزی			←→		
استخوان بالا تنه			←→		
استخوان پایین تنه		←→			
تیروئید	←→				
سیستم خون ساز	←→				
مری		←→			
تخم‌دان			←→		
پروستات			←→		

مجله پژوهش فیزیک ایران، جلد ۱۵، شماره ۲، ویژه‌نامه، تابستان ۱۳۹۴
 مهناز منتظم^۱، سیدربیع مهدوی^۲ و فرشاد قاسمی^۱

Types of RT methods

CyberKnife

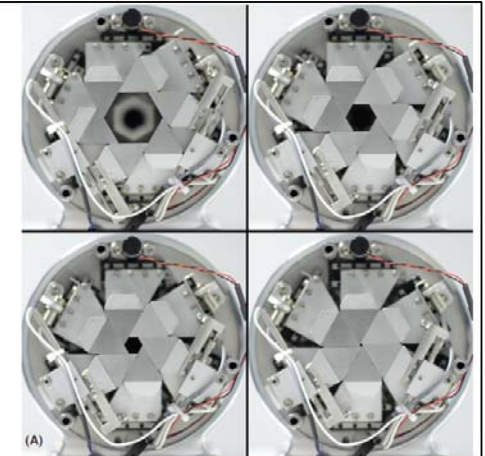


FIGURE 7.8 Closeup of the CyberKnife (A) Iris collimator and (B) InCise MLC.
Source: © 2018 Accurey Incorporated. All Rights Reserved.

Types of RT methods

GammaKnife

Advantages of Gamma Knife technology:

- 1- Reduction of side effects.
- 2- Patients can be treated in 1 session on the same day and go home.
- 3- There is no need for a period of recovery and rest.
- 4- There is no need to cut the patient's hair.
- 5- It does not cause hair loss.
- 6- The amount of harmful radiation to healthy brain tissue is reduced.

❖ Disadvantageous:

1. Source replacement
2. Treat only intracranial lesions
3. Limited field size/shaping (up-to 5.3 cm)



Fig. 2.1 Elekta GammaKnife® Icon unit, which collimates 192 Cobalt-60 sources to deliver multiple beams simultaneously

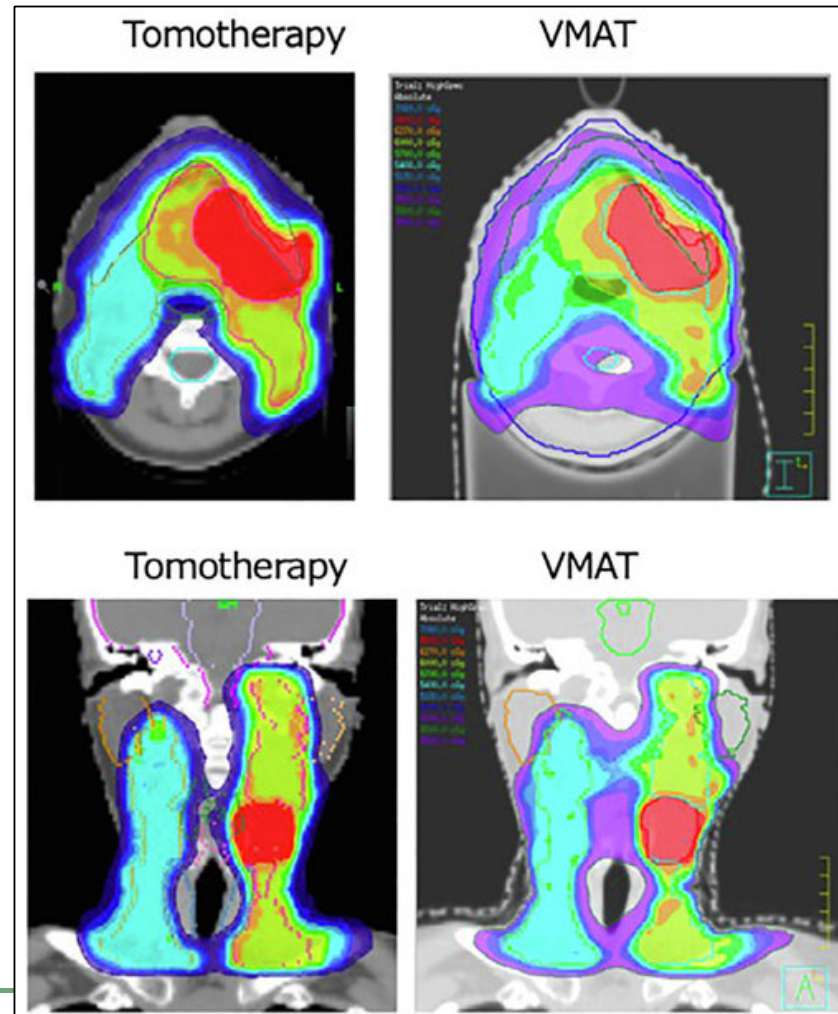
Types of RT methods

Tomotherapy



Types of RT methods

Tomotherapy



Types of RT methods

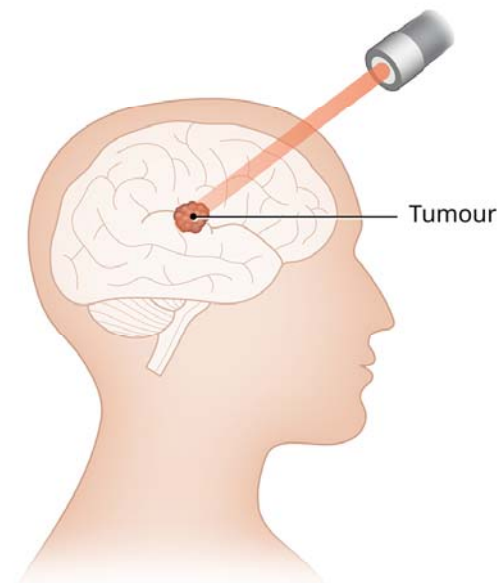
Proton Therapy



Types of RT methods

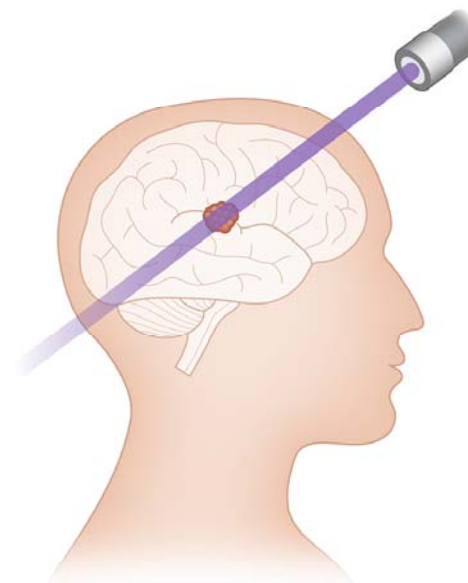
Proton Therapy

Proton Beam Therapy



Proton beam releases energy at a single point and disappears, sparing nearby organs and tissues

Radiotherapy

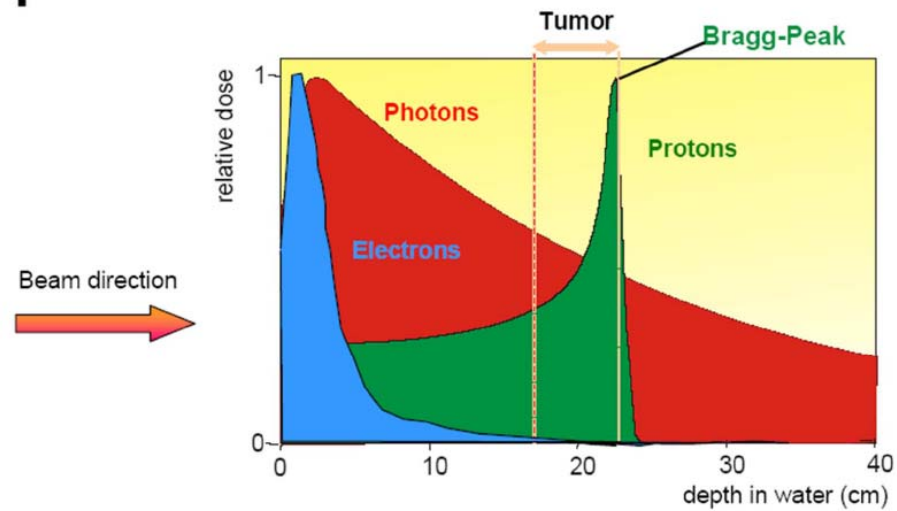


X-ray deposits energy along its path, potentially harming nearby organs and tissues

Types of RT methods

Proton Therapy

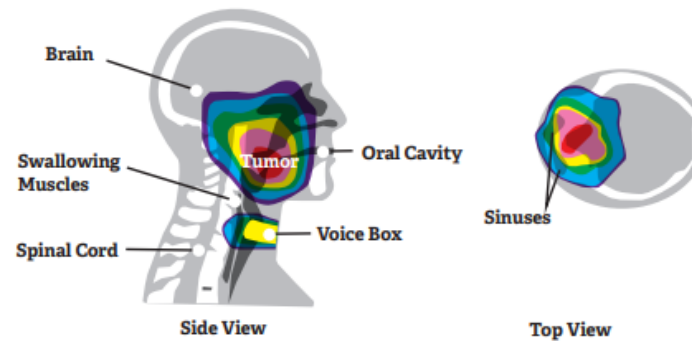
Depth Dose Considerations



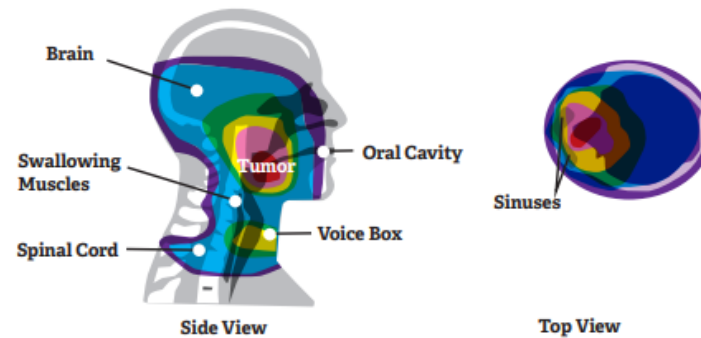
Proton Therapy

COMPARISON OF RADIATION THERAPY TREATMENT PLANS

PROTON THERAPY

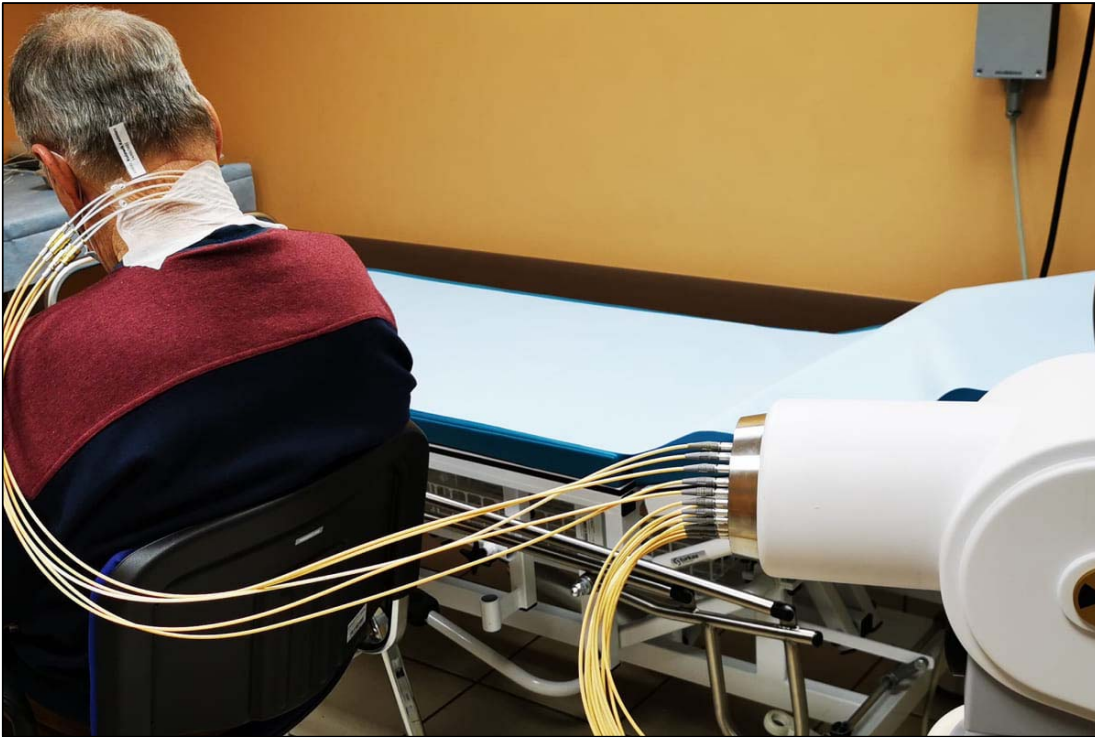


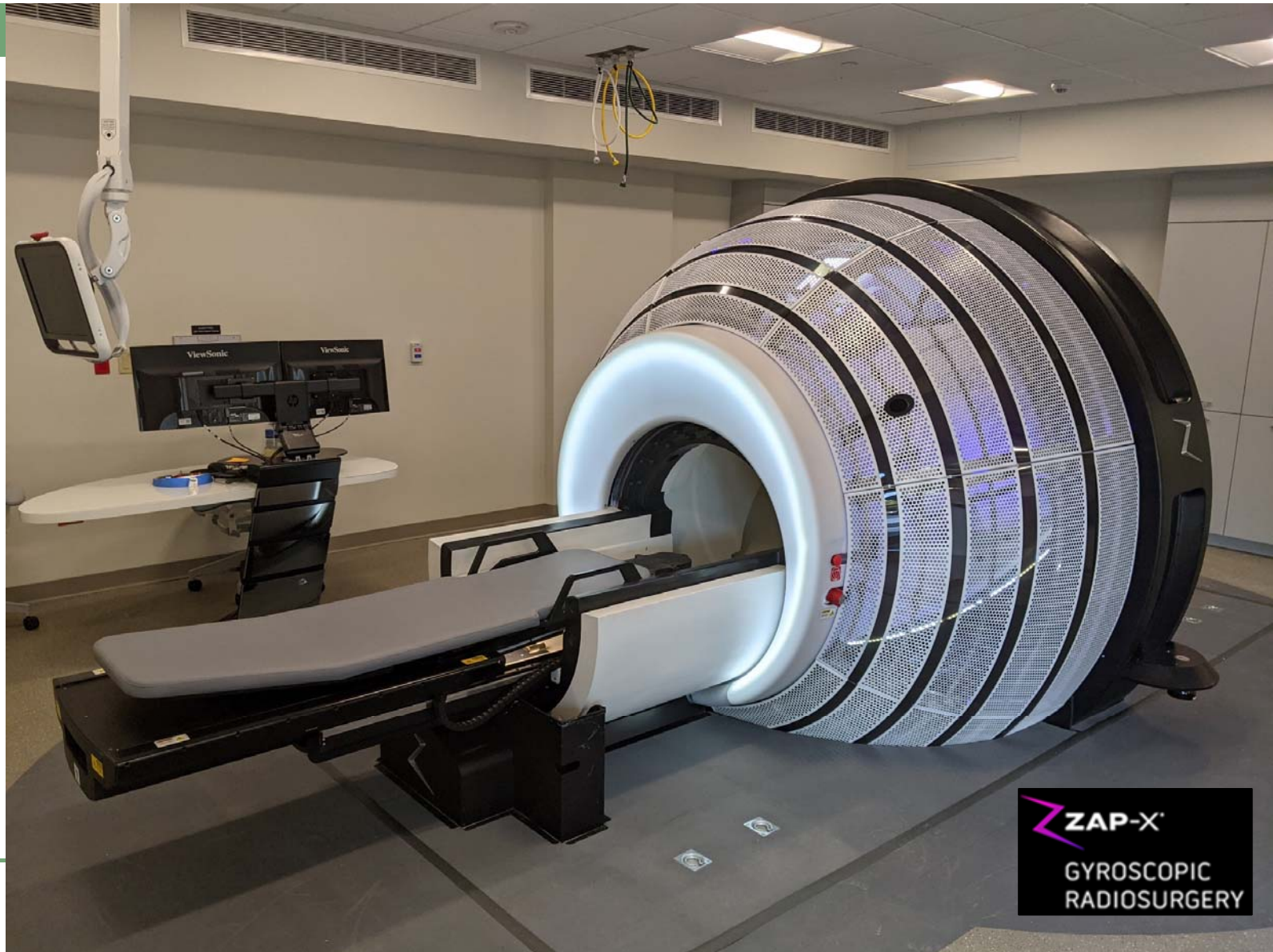
TRADITIONAL RADIATION/X-RAYS/IMRT



Types of RT methods

Brachytherapy





Types of RT methods

1. Built for Radiosurgery (Brain-head and neck tumors)
An innovative design focused solely on SRS
2. 3 MV- 1500 MU/min Linac
3. Source-Axis Distance (45 cm)
4. self-shielding technology
5. 8 Beam Apertures: 4-25 mm
6. Sub-Millimetric Targeting Accuracy



7. Intra-Fraction Image Guidance Throughout the Treatment
8. Automated Isocenter Realignment
9. Non-Coplanar
10. 2π Steradian Coverage ($\sim 360^\circ$)
11. Real-Time Beam Dosimetry
12. Vault-Free (No Need for Bunkers)

References:

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- Lecchi, Michela, et al. "Current concepts on imaging in radiotherapy." *European journal of nuclear medicine and molecular imaging* 35 (2008): 821-837.



THE END