SNS COLLEGE OF TECHNOLOGY

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Department of Biomedical Engineering

Course Name: Radiological equipment

III Year : V Semester

TITLE: Recent Techniques in Radiation Theraphy

Recent Technique in Radiation Therapy:

1. Stereotactic Radiotherapy
2. Stereotactic Radiosurgery
3. 3D CRT
4. IMRT
5. IGRT
6. Cyber Knife

Stereotactic body radiotherapy

- Stereotactic body radiotherapy (SBRT) is a type of radiation therapy that uses many beams of energy. The beams are carefully targeted to focus on growths of cells, which are called tumors, anywhere in the body. SBRT is used to treat tumors in the lungs, spine, liver, neck, lymph nodes or other soft tissues.this technique is suitable only for small, well-defined tumors that can be seen on imaging such as CT or MR scans, thus this approach is not suitable for all situations.

Types of SBRT include:

- Linear accelerator, also known as LINAC. LINAC machines use X-rays, also known as photons, to treat tumors.Proton beam, also called charged particle. This newer type of stereotactic radiotherapy uses protons to treat tumors over several sessions.
- Proton beam radiotherapy might be used to treat tumors in parts of the body that have already had radiation therapy. Or they can treat tumors that are near vital organs.

ADVANTAGES:

1. Highly effective at killing the majority of cancer cells inside a tumor.
2. It kills isolated cancer cells that surgery could not detect.
3. Shrinks tumors to make surgical removal more effective.
4. High level of patient safety.
5. Treatment is painless.

USES:

- The surgery is used to treat various brain cancers, benign, and functional disorders of the brain.
- This is sometimes combined with whole brain radiotherapy, and a 2021 systematic review found this combination led to the greatest improvement of survival for those with single brain metastasis.
- Amongst the malignant brain disorders are: brain metastasis and glioblastoma.
- The benign brain disorders are: meningioma, cerebral arteriovenous malformation, vestibular schwannoma, and pituitary adenoma.
- Functional disorders are: trigeminal neuralgia, Parkinson's disease, and epilepsy.

Stereotactic surgery:

Is a minimally invasive form of surgical intervention that makes use of a three-dimensional coordinate system to locate small targets inside the body and to perform on them some action such as ablation, biopsy, lesion, injection, stimulation, implantation, radiosurgery (SRS),

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Stereotaxic Surgery Procedure:

Incision of the skin and exposure of the cranial surface is made using a scalpel with a sterile blade and tissue retractors are placed on each side of the cranial area of interest. The bone surface is gently scraped with a periosteal raspatory or a bone scraper.

Stereotactic surgery works on the basis of three main components:

1. A stereotactic planning system, including atlas, multimodality image matching tools, coordinates calculator, etc.
2. A stereotactic device or apparatus
3. A stereotactic localization and placement procedure

3D CRT

- 3D CRT is a cancer treatment that allows doctors to direct radiation beams to conform to tumor shapes. In the past, beams only matched the height and width of the tumor and exposed healthy tissue to radiation.

Advantages:

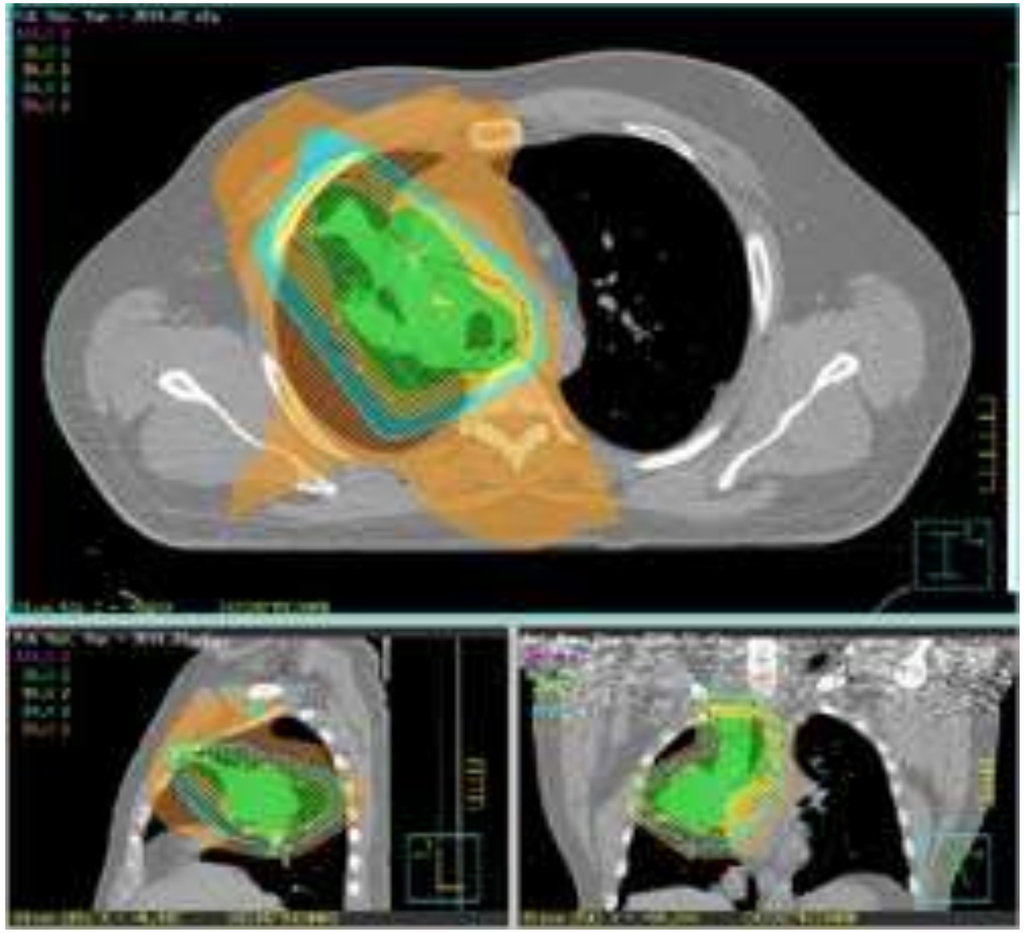
- Allows for the simulation of the patient's treatment without their physical presence after the CT scan is obtained.Treatment modifications.
- System allows for better dosimetric optimization above that which is achievable with geometric optimization alone.

Limitations:

- Knowledge of tumor extentCTV is often not fully discernible
- Patient motion.
- Biologic response of tumor.

Disadvantages:

1. Insensitive to calcification and bony structures.
2. longer time.
3. Artifacts.



Side effects of 3D-CRT:

Radiation Pneumonitis: An inflammation of the lungs that typically starts within two to three months of the start of the radiotherapy. Its symptoms can include a dry cough, shortness of breath and low-grade fever. In rare cases, it can lead to permanent scarring of the lungs.

Esophagitis: Occurs when the esophagus (the food tube that runs from the throat to the stomach) becomes inflamed. This condition typically starts about two weeks after the beginning of treatment and usually disappears about two to three weeks after treatment is completed.

Fatigue: A feeling of weakness or exhaustion that does not go away after resting. Fatigue is typically most severe two to four hours after a radiation session. It may also peak between the third and fifth week of treatment

Intensity-modulated radiation therapy :

- Intensity-modulated radiation therapy, also called IMRT, is an advanced type of radiation therapy. Radiation therapy uses powerful energy beams to kill cancer cells. The energy can come from X-rays, protons or other sources. With IMRT , the beams of radiation are carefully customized.
- Intensity modulated radiation therapy (IMRT) is the product of advances in the RT technology.
- Aims to deliver radiation more precisely to the tumor while relatively limiting dose to the surrounding normal tissues.
- The purpose of this presentation is to discuss the new concept of IMRT, its physical aspect, its applications and comparison with other RT methods.

Intensity -Modulated Radiation Therapy Delivery▸

Intensity modulated radiation therapy are delivered by three technique.

1-IMRT with fixed gantry angle

2- IMRT with Tomotherapy based

3- IMRT With rotating cone beams

1-IMRT with fixed gantry angles:

- For a given gantry angle, a computer controlled mulltileaf collimator is not only use full in shaping beam apertures for conventional radiotherapy.
- But, it can also be programmed to deliver. IMRT.
- This has been done in two different ways.
- A-segmental MLC Delivery
- B- Dynamic MLC Delivery

2- IMRT with tomotherapy based:

- Tomotherapy is an IMRT technique in which the patients is treated by slice by slice by intensity modulated beams in a manner analogous to computer tomography (CT) imaging.
- Tomotherapy is delivered in two ways-
- slice based tomotherapy-
- Helical tomotherapy

3- IMRT with rotating gantry beams:

- In this technique combines the dynamic motion of the MLC with Arc rotation of the accelerator gantry.
- IMRT delivered with rotating gantry by two ways.
- Intensity-modulated Arc Therapy (IMAT)
- Volumetric-modulated Arc therapy(VMAT)

Image Guided Radiation Therapy:

Image Guided Radiation Therapy Radiation oncologists at Penn Medicine are experts in the use of the latest therapies, including image guided radiation therapy (IGRT) to treat cancer. IGRT uses frequent imaging during a course of radiation therapy to improve the precision and accuracy of the delivery of the radiation Treatment.

In IGRT, the linear accelerators (machines that delivers radiation) are equipped with imaging technology that take pictures of the tumor immediately before or even during the time radiation is delivered.

Image Guided Radiation Therapy:

Specialized computer software compares these images of the tumor to the images taken during the simulation to establish the treatment plan. Necessary adjustments can then be made to the patient's position and/or the radiation beams to more precisely target radiation at the cancer and avoid the healthy surrounding tissue.

Benefits:

There are several advantages to IGRT therapy: More precise radiation doses can safely be delivered to tumors with fewer side effects. Reduced treatment toxicity.

Imaging used in IGRT includes:

1. Computed tomography (CT)
2. Magnetic resonance imaging (MRI)
3. Positron emission tomography (PET)
4. UltrasoundX-ray
5. The Advantage to Patients

There are several advantages to IGRT therapy:

- More precise radiation doses can safely be delivered to tumors with fewer side effects
- Reduced treatment toxicity
- Types of Cancer Treated with IGRT
- Breast cancer
- Gastrointestinal cancer such as stomach and gastrointestinal stromal tumor
- Head and neck cancer
- Lung cancer
- Prostate cancer

Disadvantages:

- Separate attachment
- Calibration of treatment and kV imaging isocentres required
- Cannot be used when the couch is rotated (to avoid collisions)
- Relatively poor contrast in 20 Images
- Lack of soft tissue detail
- Relatively high dose
- Images need to be taken in two lanes for translational errors

The Cyber Knife:

One of the most advanced forms of radiosurgery — is a painless, non-invasive treatment that delivers high doses of precisely targeted radiation to destroy tumors or lesions within the body. It uses a robotic arm to deliver highly focused beams of radiation.

The flexibility of the robotic arm makes treatment possible to areas of the body, such as the spine and spinal cord, that can’t be treated by other radiosurgery techniques.

Procedure:

Radiosurgery minimizes radiation exposure to healthy tissue surrounding the tumor. Compared to other radiosurgical treatments, the Cyber Knife offers several advantages to patients, including rapid relief from pain and other symptoms. Treatments are performed on an outpatient basis, with each treatment lasting between 30 to 90 minutes.

The number of treatments varies depending on the tumor size, location and shape but typically only one to five daily sessions are required. The Cyber Knife allows patients to lie comfortably on the procedure table without anesthesia while the robotic arm moves, without touching them, to treat all areas of the tumor.

Recovery is often immediate, given the Cyber Kife’s low risk of complications and damage to healthy tissue.Because stereotactic radiosurgery (SRS) and stereotactic body radiation therapy (SBRT) use high doses of radiation to ablate all tissue within the irradiated volume, whether it is tumor or normal tissue, in only a few fractions, precise tumor tracking is required.

The CyberKnife system is the only one that can deliver SRS and SBRT via our sophisticated technologies and tracking solutions, giving you confidence that doses are delivered with accuracy and that radiation exposure of surrounding healthy tissue and organs is minimized.

Some conditions may be treated with a different non-invasive radiotherapy device called the Gamma Knife, which also delivers a single, finely focused, high dose of radiation. At UCSF Department of Radiation Oncology, the Gamma Knife is used primarily to treat small benign or malignant brain tumors, epilepsy, trigeminal neuralgia or abnormal blood vessel formations located in the brain.