IMRT

Definition: Intensity modulated radiotherapy is a type of three-dimensional conformal radiotherapy using computer-aided optimization process to deliver customized non-uniform fluence distributions to attain certain preset dosimetric and clinical objectives.

Rationale: (1) More homogenous dose distribution within the PTV
(2) Sharper dose fall-off with less normal tissue toxicity
(3) Delivery of simultaneous integrated boost using a single plan

IMRT Process Overview:

Preparatory= Imaging + Contouring of volumes of interest + Definiton of planning objectives (dose constraints to the PTV and the OARs + definition of dose fractionatation & beam configuration)

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Treatment design /optimization→ This is an iterative process that adjusts and resets the intensities of the rays of each beam to achieve the closest possible congruence with the planning objectives. This process involves both forward and inverse planning & is a complex & time-consuming process that is only possible with computers

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Generation of leaf sequences→ In this process, the intensity distribution is converted to a sequences of leaf position

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Dosimetric variation, setup and delivery

IMRT delivery modalities:

(1) MLC-based:

(A) Multisegmented static fields (step and shoot)→ here each field is divided into a number of subfields, each with relatively uniform beam intensities, and their superimposition results in the required intensity-modulated dose distribution. In the step and shoot technique, the MLCs move to configure these different sub-fields, at a given gantry position and the beam may be either on (dynamic step & shoot) or off during their movement.

(B) Dynamic /sliding window technique→ Here the MLCs continuously sweep across the field at prefined velocities, resulting in delivery of radiation only during the time that portion of the field is not blocked (dwell time)

(C) Intensity Modulated Arc Therapy→ Here the gantry moves continuously to deliver arc therapy while the MLCs move as above.

(2) **Tomotherapy:** In this technique, a rotating slit beam is used and a temporally modulated slit MLC is used to rapidly move leaves in or out of the slit. The patient is treated slice-by-slice, analogous to a CT scan. In axial tomotherapy, the couch is moved through a certain discrete distance whereas in helical

tomotherapy, the couch rotates smoothly throughout the treatment. Examples of the tomotherapy units are the NOMOS Peacock system which uses MiMiCs.

Simultaneous Integrated Boost (SIB):
Also called Simultaneous Modulated Accelerated Radio Therapy
Here IMRT plan is generated to treat all target volumes in a single plan simultaneously, but using different fraction sizes. The advantage of this technique is the avoidance of different plans, electron beams and field junctions. SMART has been used in Ca H& N to simultaneously deliver the biologically equivalent doses of 70 Gy to the gross disease, 60 Gy to the high-risk sub-clinical disease and 50 Gy to the low-risk sub-clinical disease.

Evaluation of IMRT plan: Using DVH, calculating maximum and minimum doses to a particular volume of interest.

Verification of IMRT plan: (1) In-vivo dosimetry using TLP/ silicon diodes
(3) Electronic Portal Imaging Devices (EPID)→ video-based, liquid ionization-chamber based→ these use exit dosimetry

Applications of IMRT:
(1) Ca Prostate
(2) Ca Head & Neck
(3) Ca Breast
(4) Ca Pancreas

Results: IMRT allows greater local control in most sites, leading to superior disease-free survival. It also reduces normal tissue toxicities, especially xerostomia in H&N radiation and rectal complications in prostate irradiation.