Radiotherapy of head and neck, breast, lung and colorectal cancer

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Radiotherapy (radiation therapy)

- is the treatment of cancer and other diseases with ionizing radiation

Radiobiology

- injures or destroys cells in the area being treated by damaging their genetic material,
- making it impossible for these cells to continue to grow.
- radiation damages both cancer cells and normal cells,
- the latter are able to repair themselves and function properly

Isotope

- Radioactive decay - the process by which an atomic nucleus of an unstable atom loses energy by emitting ionizing particles (ionizing radiation): natural and artificial
- alpha rays carried a positive charge (particle radiation)
- beta rays carried a negative charge (particle radiation)
- gamma rays were neutral (electromagnetic radiation)

Coolidge tube

- the electrons are produced by thermionic effect from a tungsten cathode heated by an electric current.
- the high voltage potential
- low-energy - 50-150 kV

  orthovoltage – 150-500 kV

Cobalt machine

- Radioactive isotopes Cobalt-60
- Gamma rays
- Disadvantage : penumbra, one energy -1,25 MV (1,17 and 1,33), worse personnel protection, decreasing with time activity, need store back used sources

Linear accelerator

- Cathode, anode
- Voltage potential
- Accelerating section
- Megavoltage – 4-25 MV
- Photons, electrons

Radiotherapy

- -teleradiotherapy
- -brachytherapy
- -isotope therapy

Isotope therapy (nonsealed radionuclide therapy)

- oral or intravenous administration of a radiopharmacuetical
- in benign and malignant thyroid disease (Iodine ^{131}I)
- in bone metastases (Strontium ^{89}Sr and Samarium ^{153}Sm)

Brachytherapy

- involves placement of the radiation source in contact with the body whether the source be physically implanted into the tissues
- Radioactive isotopes: Radium 226, Caesium 137 , Iridium 192, Iodine 125 or 131, Gold 198, Phosphorus 32

Brachytherapy

- contact therapy- approximated to the body surface (skin, mucosa)
- interstitial therapy(breast, lip, tongue, floor of the mouth, prostate)
- intracavitary therapy-into existing cavities (cervix, uterus , vagina)
- intraluminal- (oesophagus, trachea, bronchi)
- intravascular (coronary in-stent restenosis)

Brachytherapy

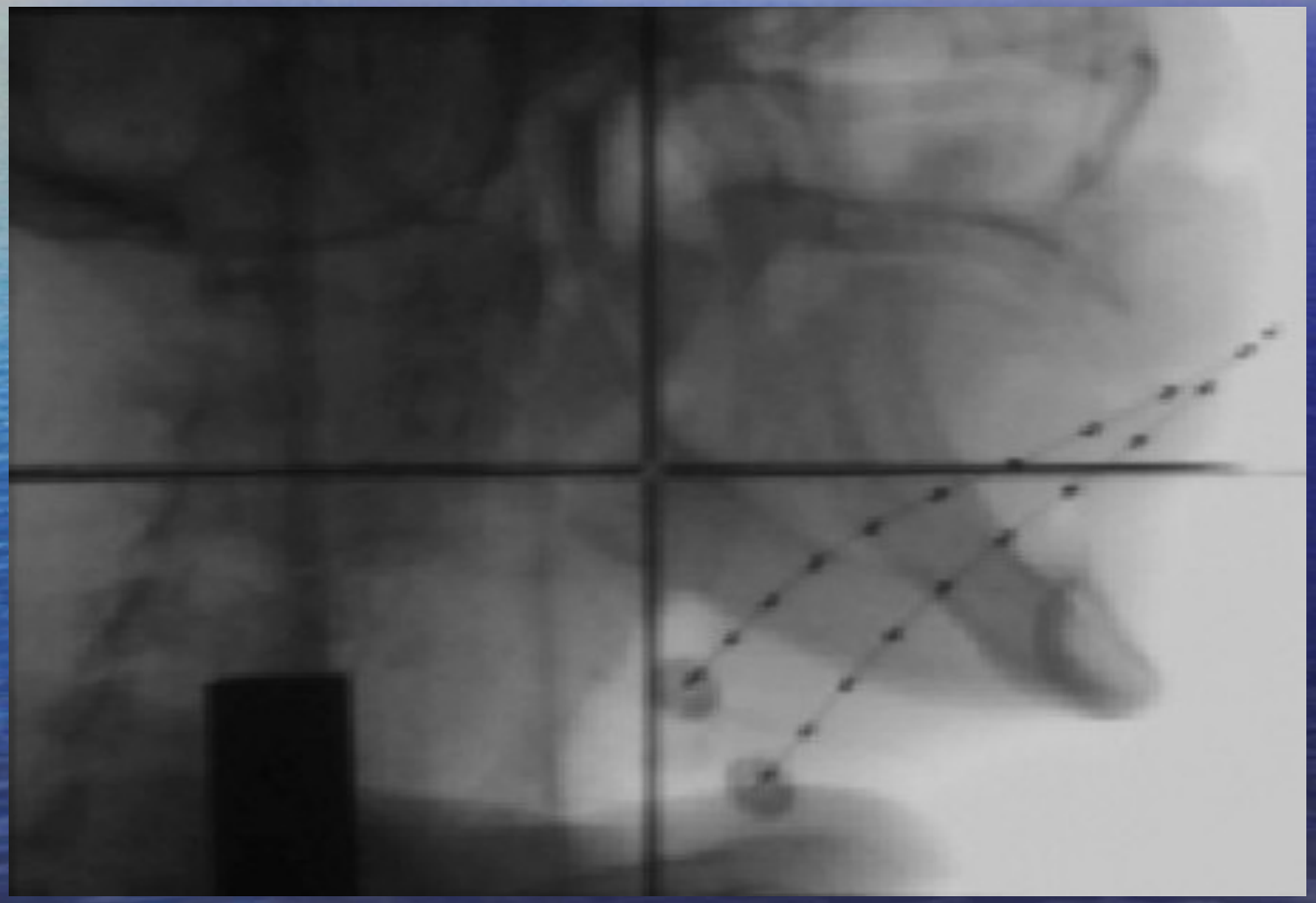
- LDR (Low-dose rate) - a medium rate of dose delivery up to 2 Gy. hr-1 (oral cavity, oropharynx, sarcomas, prostate cancer)
- MDR (Medium-dose rate) - ranging between 2 Gy.hr-1 to 12 Gy.hr-1
- HDR (High-dose rate) - exceeds 12 Gy.hr-1.(cervix, oesophagus, lungs, breasts and prostate)
- PDR (Pulsed-dose rate) involves short pulses of radiation, typically once an hour, to simulate the overall rate and effectiveness of LDR treatment. (gynaecological and head and neck cancers)

Brachytherapy

Afterloading system

- automatically places the radioactive source at predetermined positions within the applicator and stores the source between treatments.
- while the patient is being treated, the personnel is able stay outside the treatment room to avoid radiation exposure.

BRACHYTHERAPY – floor of the mouth (localization film with 2 applicators)



EBRT (external beam radiotherapy, teleradiotherapy)

- involves the delivery of radiation from a source located external to the body
- this is the most common type of radiation therapy (X-ray generator, cobalt-60 unit, linear accelerator- photons, electrons)
- Another EBRT techniques: by using protons and neutrons

Radiation therapy treatment	palliative	radical
aim	to decrease tumor mass	to destroy the tumor
effect	to decrease symptoms	to cure
treatment time	1-5 days	4-7 weeks
total dose	8-30 Gy	>50 Gy
dose per fraction	3-10 Gy	1,8-2 Gy
treatment fields	tumor	tumor +region of micrometastases

FRACTIONATION SCHEDULES

- **Conventional fractionation**
  - daily fractions 1,8-2 Gy
  - 5 days per week (Monday-Friday)
  - total dose 35-80 Gy
- **Hyperfractionation**
  - 2 or more fractions per day
  - increased total dose in the same treatment time as in conventional fractionation,
  - dose per fraction 1,5-1,8 Gy,
  - the time interval between the dose fractions et least 6 h to allow cellular repair
- **Hypofractionation**
  - higher dose per fraction
  - shorter total treatment time
  - lower total dose
- **Accelerated fractionation**
  - number of fractions, fraction and total dose the same
  - 6 or 7 days per week (total time of treatment is reduced)

Preparation for radiotherapy- mould room

- **Individual positioning for the patient:**
- **Individual mask - (small or large)**
- **PediBoard**
- **Wing board - the system used to immobilize the patients with chest cancer**
- **Posiboard - the system used to immobilize the patients with breast cancer**

Preparation for radiotherapy

Large and small individual mask – from posicast termoplastic material used to immobilize the patients with head and neck cancer

Preparation for radiotherapy

Vac-lok - vacuum locking system to imobilize the patients with gastric, rectum, ovarian cancers and lymphoma

Preparation for radiotherapy

Wing board - the system used to immobilize the patients with lung, oesophageal cancers.

Preparation for radiotherapy

Posiboard - the system used to immobilize the patients with breast cancer.

Preparation for radiotherapy - CT

The patient during computed tomography.

Preparation for radiotherapy

Simulator

Planning

- 2D (two dimensional)
  - by using simulator (bone structures)
  - mainly in palliative treatment
- 3D (three dimensional)
  - by using CT
  - in radical treatment
- Planning targets (in 3D):
  - GTV- gross tumor volume
  - CTV- clinical target volume
  - PTV planning target volume
  - critical organs

Planning

- 3D planning system

Treatment- linear accelerators

Elekta –

X-rays (6 and 15 MV)

Electrons: 6,9,12,15,18 MeV

Artiste –

X-rays (6 and 15 MV)

electrons: 6,9,12,15,18 MeV

Treatment- in-vivo dosimetry

The measurement of dose on the patient `s skin during irradiation by radiation Mosfet detector, which we used during first fraction each stage of treatment.

Treatment- electronic portal imaging

Indications for radiation therapy

Radiotherapy alone	Radiotherapy in combined-modality therapy
Head and neck cancers	Breast cancer
Lymphomas	Anal cancer
Cacinoma of uterine cervix	Lung cancer
Lung cancer	Head and neck cancers
Esophageal cancer	Sarcomas
Anal cancer	Brain tumors
Prostate cancer	Lymphomas
Bladder cancer	Carcinoma of endometrium
Skin cancer	Thyroid cancer

Treatment metods

- Kind of tumor (localization, histopatology)
- Tumor advance
- Performans status

Head and neck cancers

- Nasopharyngeal carcinoma (upper part of pharynx)
- Cancer of the nasal cavity and paranasal sinuses
- Cancer of the oral cavity
  (lips, gingiva, buccal mucosa, hard palate, floor of mouth, anterior two-thirds of the mobile tongue)
- Carcinoma of the pharynx:
  oropharynx (tonsils, base of tongue)
  hypopharynx (laryngeal part of pharynx)
- Laryngeal cancer: supraglottic
  glottic
  subglottic
- Salivary glands cancer (submandibular, parotid, sublingual gland, minor salivary glands)

Head and neck cancers

NON-ADVANCED LARYNGEAL AND PHARYNGEAL CANCER (T1,T2)

- Teleradiotherapy or surgery
- PTV :glottic cancer T1-T2: - larynx with margin
- another localization- tumor with regional lymph nodes

ADVANCED LARYNGEAL AND PHARYNGEAL CANCER (T3,T4,N1-3)

- chemoradiotherapy
- neoadjuvant chemotherapy + teleradiotherapy or surgery
- teleradiotherapy of non-advanced primary tumor + surgery of metastatic lymph nodes
- surgery (total laryngectomy with different types of neck dissection) + adjuvant radiotherapy/chemoradiotherapy

Head and neck cancers- larynx et pharynx

Indication for postoperative (adjuvant) irradiation:

- large primary tumor T3,T4
- non-radical or narrow surgical margin
- lymph node metastases
- extracapsular spread of lymph node metastases
- low grade histopathology G2,G3
- subglottic extension

Head and neck cancers- nasopharynx

- T1,T2 N0 : radiotherapy alone
- T3,T4, N+: radiochemotherapy
- PTV: pharynx, involved tissues and regional lymph nodes

Head and neck cancers- oral cavity

- T1N0 : Surgery (or brachytherapy)
- T2N0: Surgery +/- radiotherapy
- T3, T4 N0 or T N1-3: Surgery +/- radiotherapy or chemoradiotherapy
- Alternative treatment - radiotherapy or chemoradiotherapy (without infiltration of the mandible)
- Inductive chemotherapy (if infiltration of the mandible)

Head and neck cancers- salivary gland

- Surgery
- Adjuvant radiotherapy (if indication)

Head and neck cancers- paranasal sinus

- T1-4 N0: Surgery + postoperative radiotherapy (if needed)
- If non operable- palliative radiotherapy or chemotherapy

Head and neck cancers- FPI (unknown primary focus)

- Surgery (MRND or RND) + radiochemotherapy

Head and neck cancers

REMEMBER ABOUT DENTAL TREATMENT !!!

Breast cancer

After breast-conserving treatment (tumorectomy, quadrantectomy with axial lymphangectomy or remove guard node)

- T1,T2
- PTV : a breast +/- regional lymph nodes
- total dose 50Gy/25fr.
- boost to tumor site 10Gy to total dose 60Gy (can be administered by teleradiotherapy, brachytherapy) or intraoperative electron-beam radiotherapy.

Breast cancer

After mastectomy modo Patey or Madden, Halsted etc.

- Adjuvant irradiation if R1, N+,T3-4
- If N +

  Irradiation of chest wall and regional lymph nodes (axillary, retrosternal, supra- and infraclavicular) to total dose 50Gy/25fr.
- If N -

  Irradiation of chest wall

LUNG CANCER

Small cell lung cancer
SCLC

Non-small cell lung c.
NSCLC

limited disease LD

extensive disease ED

resectable

non resectable

RESECTABLE NON-SMALL LUNG CANCER

- I, II, III A: (T1-2, N0-1, T3 N1) : Surgery

- Radical irradiation (patient refuse to surgery or contraindication to surgery); 5-years overall survival <10%)

p II, P IIIA → neoadiuvant or adjuvant chemotherapy (or combined chemoirradiation if indication for radiotherapy)

Indications for postoperative radiotherapy:

- R1 surgery (non-radical microscopic surgical margins)
- pN2 ? – in prospective studies

dose 50-70 Gy, PTV: tumor bed or tumor with margin

UNRESECTABLE NON-SMALL CELL LUNG CANCER

Radiotherapy or chemoradiotherapy (concomitant or neoadjuvant chemotherapy followed by radiotherapy)

- If good performans status
- dose to 66- 70 Gy in classical fractionation , PTV: tumor and involved lymph nodes

Treatment schedules with accelerated hyperfractionation (in clinical trials)

e.g. CHART (irradiation to total dose 54 Gy t.i.d. in 12 days)

SMALL CELL LUNG CANCER
LD

Combined chemoradiotherapy

dose : 55-60 Gy

PTV: tumor, involved lymph nodes and adjacent lymph nodes

RT started with I or II chemotherapy cycle

radiological studies (CT, MRI) performed before chemotherapy

SMALL CELL LUNG CANCER

Ellective cranial irradiation (PCI)

- in 50-80% of patients – brain metastases
- PCI in patients with PR or CR
- dose 25 Gy/10 fr./2 weeks

RECTAL CANCER

TREATMENT IS BASED ON SURGERY

- Tumor excision
- Anterior resection
- Abdominoperineal resection

Radical radiotherapy- only if surgery isn't possible

Adjuvant chemotherapy

is recommended in patients with adverse prognostic factors in histopathological examination

RECTAL CANCER

- **Preoperative radiotherapy** (Better local control than in postoperative chemoradiotherapy.)

- primarily resectable tumor (8-12 cm above anal canal)
  - RT alone
  - dose 25 Gy/5 fr/5 days
  - surgery after few days (prospective trial with surgery 4 weeks after radiotherapy)

- unresectable tumor

chemoradiotherapy based on 5FU ; dose 50-50,4 Gy/25- 28 fr./ 5 weeks +/- „boost”, surgery after 4-6 weeks

RECTAL CANCER

POSTOPERATIVE RADIOTHERAPY – INDICATIONS:

- Tumor T3,T4 (8-12 cm above anal canal)
- Lymph node metastases
- Non-radical surgical resection
- Narrow surgical margin
-

Dose 45-50 Gy/25-28 fractions/5 weeks.
Usually with concurrent 5-FU based chemotherapy

CANCER OF ANAL CANAL

Irradiation with concurrent chemotherapy 5-FU+ Mitomicin C

- anal sphincter-preserving treatment
- surgery reserved for failures

Gastric cancer

- Surgery
- III , IV: chemotherapy neo and adjuvant
- P T3, pT4, N+: adjuvant concomitant radiochemotherapy
- Dose: 45 Gy / 25 fr.
- PTV: tumor bed + regional lymph nodes

PROSTATE CANCER

- **radical prostatectomy** (T1-2 N0, life expectancy more than 10 years)

  (prostate + seminal vesicles + pelvic lymph nodes)
- Postoperative adjuvant radiotherapy is performed in case of positive surgical margins, p T3, PSA +
- **radical radiotherapy** (conformal teleradiotherapy or brachytherapy +/- hormonotherapy)

  Dose: 70-80- Gy

  PTV: estimate risk of nodal and seminal vesicle involvement (Gleason score and PSA)

- *Results are equal. Ask patient about the preferable treatment method.*

BLADDER CANCER

Superficial cancer- : TUR

Tis, T1G3: TUR + intravesical chemotherapy or immunotherapy (BCG), to consider early cystectomy

Tumor invades muscle:

radical cystectomy

radiotherapy +/- neoadjuvant chemotherapy Cis-Pt

concurrent chemoirradiation (only if surgery isn't possible)

Tumor invades surrounding organs:

palliative radiotherapy, surgery or chemotherapy

GINECOLOGICAL CANCERS

CARCINOMA OF UTERINE CERVIX

- CIN III, Ia1: conservative surgery (resection of uterine cervix, conisation)
- Ia2: radical surgery +/- radiotherapy
- Ib- IIa: radical radiotherapy or surgery +/- adjuvant RT
- II b, III , IVa : chemoirradiation (tele+brachy+Cis-Pt)

Brain Tumor

- Astrocytoma: PTV- tumor bed + margin
- I,II- non radical resection
- III,IV- always adjuvant radiotherapy
- Ependynoma- always adjuvant radiotherapy

  PTV- all CNS (brain + spinal cord)
- Meduloblastoma and PNET- always adjuvant

  RTH- all CSN
- Meningioma - PTV tumor bed + margin

  Indication: anaplastic, atypic?- always, another

  after non radical resection
- Brainstem tumors - 80 % inoperable- only RTH

GINECOLOGICAL CANCERS

ENDOMETRIAL CARCINOMA

- I:- surgery +/- adjuvant RT (tele- and brachy)
  - radiotherapy alone (alternative treatment)
- II- surgery + radiotherapy
- III- radiotherapy alone +/- hormonotherapy or chemotherapy
- IV-palliative radiotherapy or combined-modality therapy (resection, radiotherapy, hormonal treatment, chemotherapy)

LYMPHOMAS

HODGKIN'S DISEASE

Main treatment: chemotherapy

+ RT of involved fields (if PR)

Dose: 20-36 Gy

- reduced toxicity of treatment (less cytotoxic drugs and decreased radiation dose)
- stage III i IV, „bulky disease", B symptoms (fever, night sweats, unexplained loss of >10% of body weight in the 6 months before diagnosis)

PALLIATIVE RADIOTHERAPY

- Cerebral metastases (RT or steroids)
- Bone metastases
- Spinal cord compression
- Superior vena cava syndrome
- Dyspnea (airway obstruction)
- Dysphagia (cancer of esophagus, pharynx)
- Tumor compression on surrounding structures (pain)
- Bleeding (hemoptysis, ginecologic bleeding, rectal bleeding)

Benign Diseases

- Keloids
- Thyroid Ophthalmopathy
- Orbital pseudotumors (lymphoid hyperplasia)
- Heterotopic ossification
- Paragangliomas
- Ginecomastia

Acute side effects

Mucositis (dysphagia, sore throat, hoarseness, xerostomia)

Erythema

Laryngeal oedema

Diarrhea

Dysuria

Late side effects

Chondronecrosis

Bone necrosis

Laryngeal oedema

Subcutaneous fibrosis

Chronic otitis

Blindness (retinopathy or neuropathy)

Ureteral injury, ureteral obstruction

Rectal bleeding

Impotence

Worsening renal function and liver

Thank you