PRINCIPLES OF BRACHYTHERAPY

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BASIC PRINCIPLES

- The basic principles of brachytherpy have not changed much during the years of evolution of radiotherapy

- Recent advances has made brachytherapy more efficient for the patient and more safe for the staff from radiation protection point of view

- **Brachy means short**
- Discrete sources
- Close proximity
- Rapid dose fall off

IDEAL CHOICE OF RADIONUCLIDE

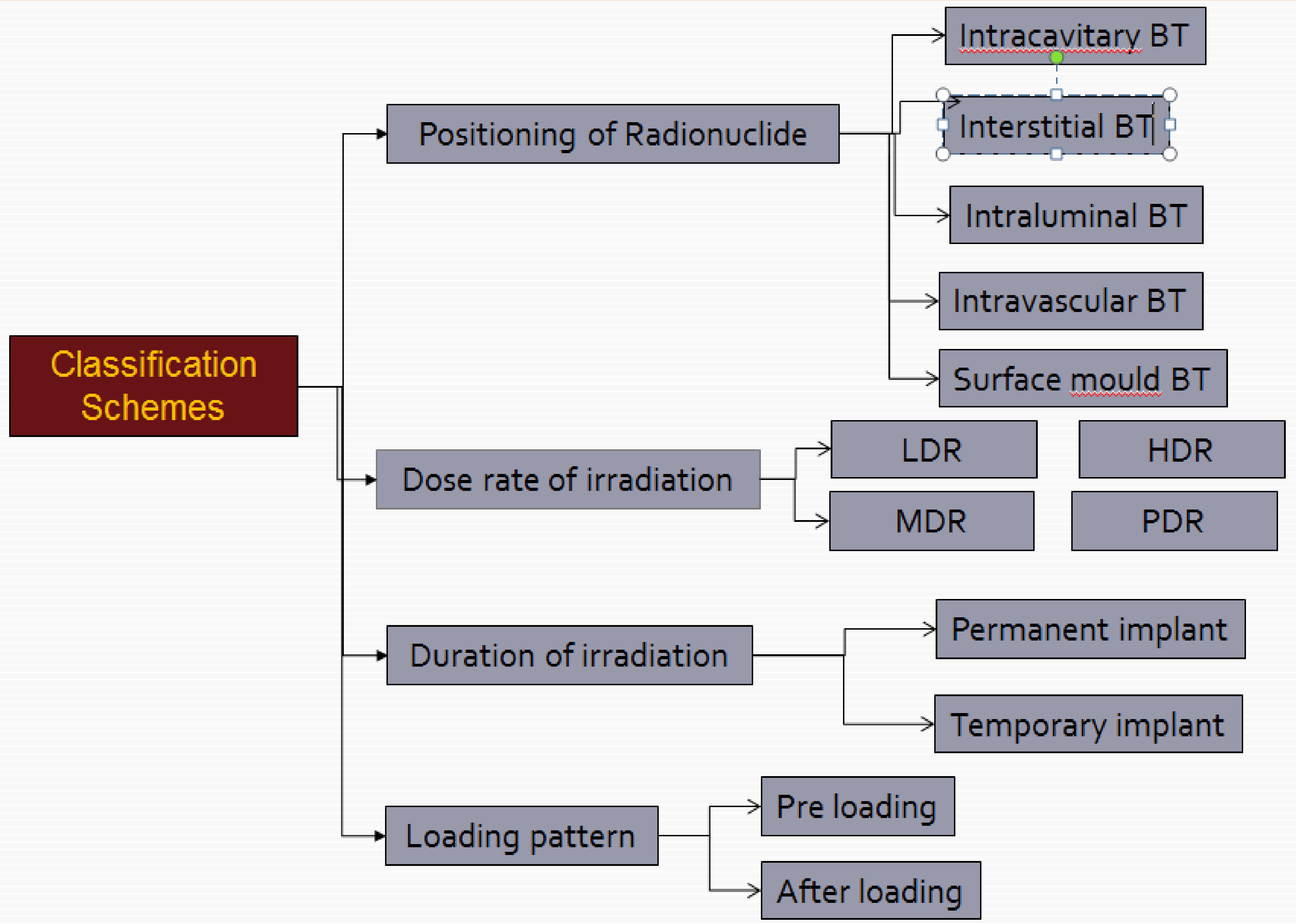
- Photon energy :low to medium- 0.03 to 0.5 MeV
  - Monoenergetic beam preferred
- Moderate Gamma ray constant
- Long half life
- High specific activity
- Isotropic
- No gaseous disintegration/daughter product
- Nuclei should not disperse if source damaged
- Low beta energy
- Low or no self attenuation
- Insoluble and nontoxic
- Flexible
- Easily available and cost effective
- Withstand sterilization process
- Disposable without radiation hazards to environment

HISTORIC OVERVIEW

- Radioactivity was described by Becquerel in 1896.
- Marie curie extracted radium in 1898.
- Danlos and Bloc performed first radium implant (1901).
- First “schools” of brachytherapy at Stockholm , Memorial Salon Kettering and the Holt Radium Institute (Paris).
- Ra & Rn –two radioactive sources used extensively in the early years.

HISTORIC OVERVIEW

- The term brachytherapy proposed first time by Forsell in 1931.
- From 1940 – 1970s , **Co^{60}**, **Cs^{137}**, Ir^{192} first used in brachytherapy.
- In 1953, afterloading technique first introduced by Henschke in New York – removed hazard of radiation exposure. Also Ir used first time by Henschke.
- LDR brachytherapy became the gold standard.



Classification Schemes
Positioning of Radionuclide
Intracavitary BT
Interstitial BT
Intraluminal BT
Intravascular BT
Surface mould BT
Dose rate of irradiation
LDR
HDR
MDR
PDR
Duration of irradiation
Permanent implant
Temporary implant
Loading pattern
Pre loading
After loading

- SURGICAL APPROACH / POSITIONING
  - SOURCE IN TUMOR
    - INTERSTITIAL
    - INTRACAVITARY
    - INTRALUMINAL
    - ENDOVASCULAR
  - SOURCE IN CONTACT BUT SUPERFICIAL
    - SURFACE BRACHYTHERAPY/ MOULAGE

- DURATION OF IRRADIATION
  - TEMPORARY-Cs^{137},Ir^{192}
  - PERMANENT-I^{125},Au^{198}

DOSE RATE (ICRU 38)

- LOW DOSE RATE (LDR)
  - 0.4-2 Gy/hr
  - Cs^{137}
- MEDIUM DOSE RATE (MDR)
  - 2-12 Gy/hr
- HIGH DOSE RATE (HDR)
  - > 12 Gy/hr
- ULTRA LOW DOSE RATE
  - 0.01-0.3 Gy/hr
- ROUGHLY
  - LDR – 10 Gy/day
  - MDR -10 Gy/hr
  - HDR – 10 Gy/min

SOURCE LOADING TECHNIQUE

- PRELOADING SYSTEM
  - Live sources
  - ADVANTAGES
    - Clinical results are best
    - Affordable
    - Long term results with lesser morbidities
  - DISADVANTAGES
    - Radiation hazards
    - Special instruments
    - Difficult application / hasty
    - Geometry not maintained
    - ? Optimization

AFTER LOADING TECHNIQUE

- MANUAL
  - Avoids radiation protection issue of preloading
  - Better applicator placement
  - Verification prior to source placement
  - Min. radiation hazard
  - Advantages of preloading

AFTER LOADING TECHNIQUE

- REMOTE CONTROLLED
  - No radiation hazard
  - Accurate placement
  - Geometry maintained
  - Better dose distribution
  - Highly precise
  - Short T/T time
  - Day care procedure
  - Mainly used for HDR

SURFACE MOULD

- Superficial tumour.
- Contour of the lesion is simulated – tissue equivalent material.
- Mould is placed over the skin surface.
- Source form – tube, needle and seeds.
- Distance between the source and skin depends upon the depth below the surface to be irradiated.
- Distances of 0.5 or 1 cm are generally used.
- Alternate mode is electron beam.
- Example: ear, lip, floor of mouth, penis.
- Material used for mould: Plastic compounds (perspex, bexoid), self-adhesive elastoplasts, plaster of paris, wax.
- Homogeneous the variation should not be more than ±10%.

- **Mould Types**
- Planar
- Linear
- Cylinder

Planar: plane or its curvature is less than that of hemi-sphere or semi-cylinder

- **Source arrangements in moulds**
- **Circle**
- **Square**
- **Rectangle**

Selection of treatment distance 'h', the distance between source plane and treatment surface, depends on the depth dose required and also dose to other tissues surrounding the implant.

PATERSON-PARKER SYSTEM

- Uniform dose to the plane or volume of interest.
- Distribution rules are more elaborate and complex.

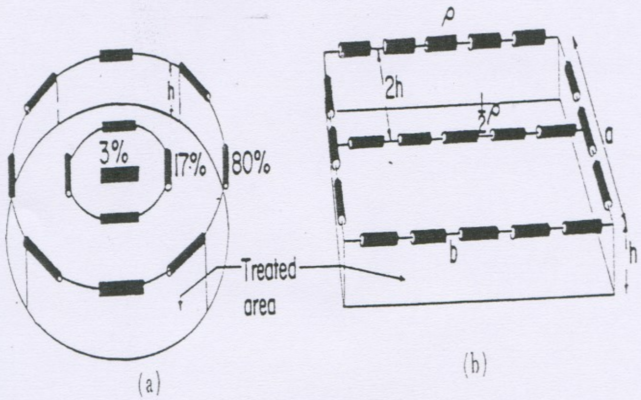
Plane circular Mould

- Area to be treated: circular in shape.
- Source distribution: depends on diameter of the circle d and the distance between the planes h.
- Single circle : if d/h = 3.(ideal is d/h=2.83)
- Distribution rule:

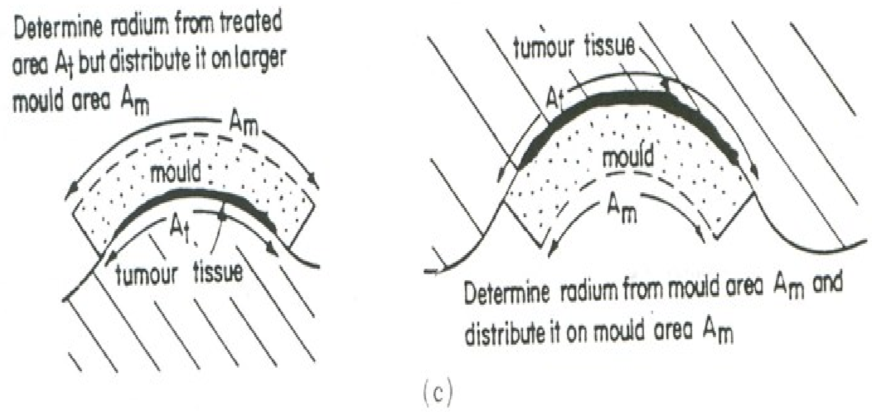
d/h	Outer circle	Inner Circle	Centre
< 3	100 %	-	
3 - <6	95%	-	5%
≥ 6	80 %	17%	3%

The inner circle is half the diameter of outer circle.

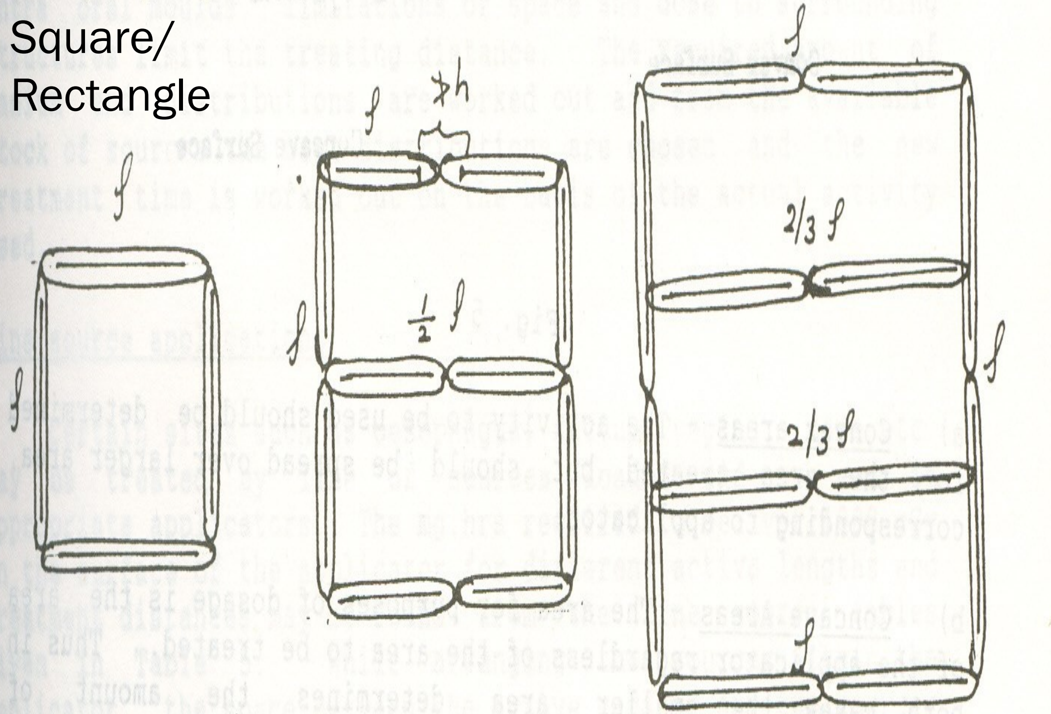
Plane or Circular



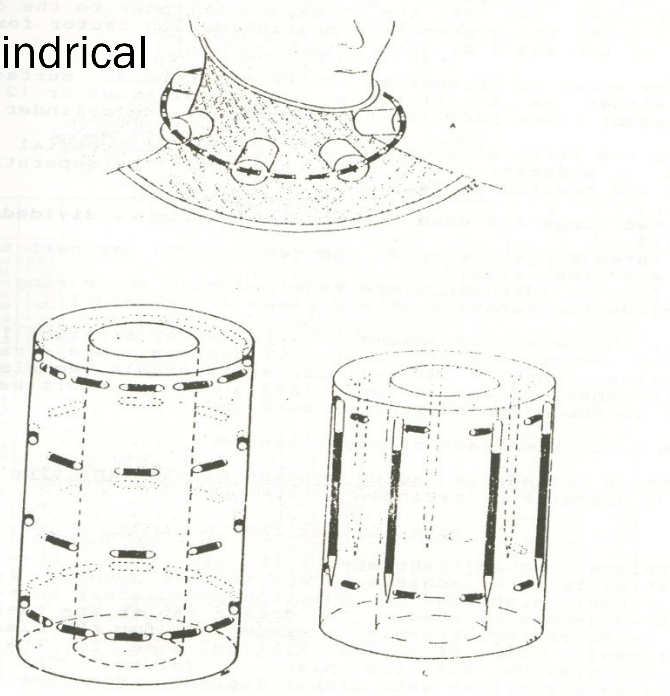
Curved surface



Square/ Rectangle



Cylindrical



INTERSTITIAL BRACHYTHERAPY

- Sealed Radioactive sources directly implanted into the tumor in a geometric fashion
- First suggested by Alexander Graham Bell
- ADVANTAGES
  - Higher local dose in shorter time
  - Rapid dose fall
  - Better tumor control
  - Lesser radiation morbidities
  - Superior cosmetics
  - Functional preservation of organs

INTERSTITIAL BRACHYTHERAPY

- DISADVANTAGES
  - Radiation hazards in older days
  - Costly
  - Not applicable to inaccessible areas
- INTENTION OF TREATMENT
  - Always RADICAL
    - As radical brachytherapy alone (smaller lesions)
    - Local boost in combination with EBRT (larger lesion)
    - NEVER USED FOR PALLIATION

- Sources directly implanted into tissues in and around the malignant growth.
- For less accessible sites, permanent implants with short-lived radionuclide.
- Advantage: very high dose to the tumour lesion, while giving very low dose to surrounding normal tissues.
- Drawback: Absolute dose homogeneity is not possible because of the intensely high zone of the radiation immediately surrounding the implanted needle and seed sources.
- Examples: Oral cavity, breast and other sites.
- Classification: Planar and Volume implant.
- Planar implant: 1. when tumour spread is under the skin surface

  2. when lesion can be sandwich between the parallel planes of implant.
- Volume implant: 1. when lesion to be treated is more than 2.5 cm thick.

  2. plane implant leads to low dose region midway between the planes.

  3. shape: sphere, cube and cylinder.

PLANAR IMPLANT

Technique used: When tumour spread is under the skin / lesion can be sandwiched between parallel planes of implant.

Single plane implant:

- Effectively irradiate tissues of 1 cm thickness (0.5 cm on either side.
- Reference dose plane is 0.5 cm from source plane.
- The dose at 0.5 cm is the minimum dose throughout the 1 cm thick slab.
- The high spots immediately surrounding each source are assumed to be tolerated by tissues and its presence is ignored.
- Distribution laws:

Area (cm^2)	Fraction of Activity on Periphery	Area
< 25	2/3	1/3
25-100	1/2	1/2
> 100	1/3	2/3

PLANAR IMPLANT

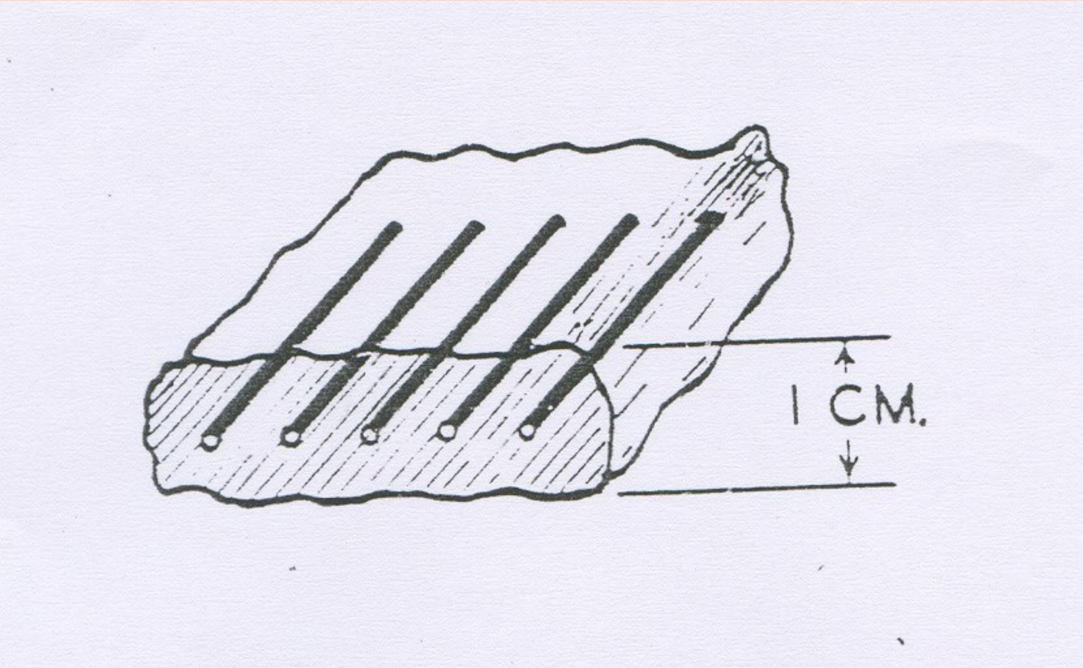
Rules:

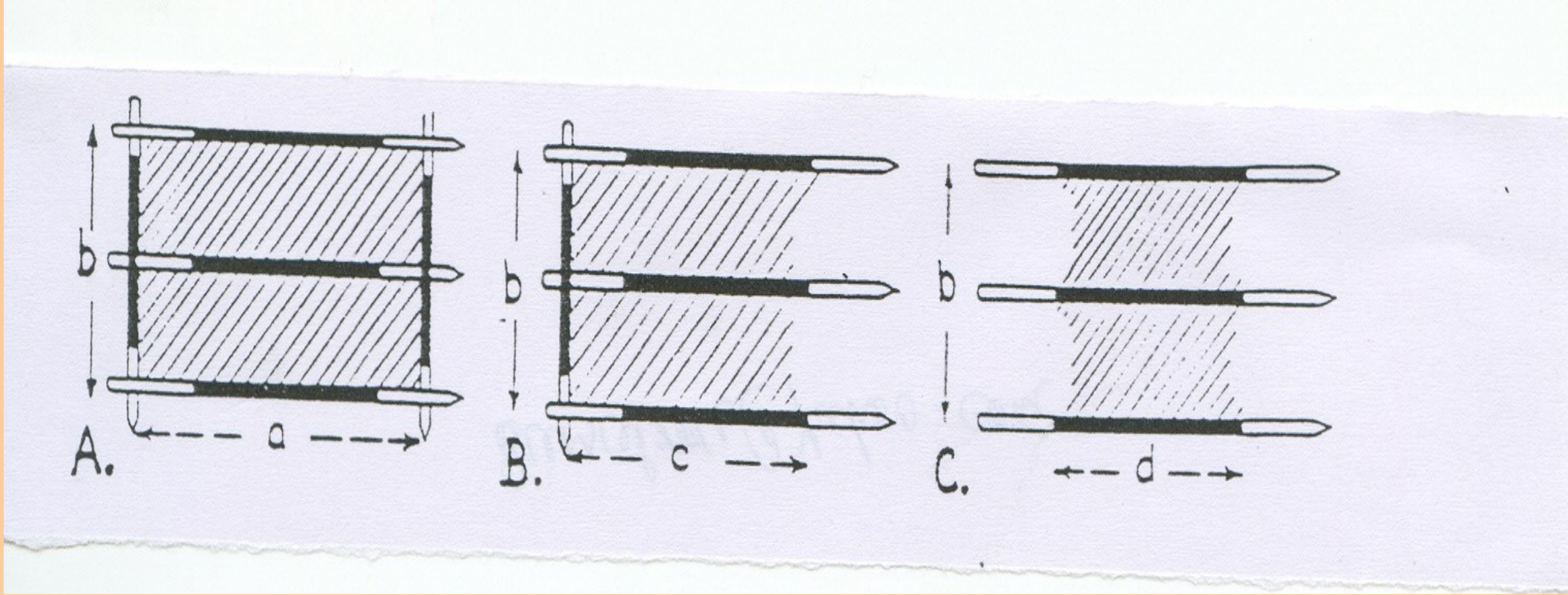
- Needles spacing: not more than 1 cm. from each other.
- For uncrossed ends: effective area has to be reduced by 10% for each uncrossed ends. Fig.B effective area is 0.9 x b x c and for Fig. C, it is 0.8 x b x d

Multi planar implant:

- Planes should be parallel to each other.
- Two plane implant: 1.5/2.0/2.5 cm.
- Separation is more than 1.0 cm between the planes then

Plane Separation	Multiplication Factor
1.5	1.25
1.6	1.40
2.5	1.50


1 CM.


b
a
A.
b
c
B.
b
d
C.

VOLUME IMPLANT

- When the lesion > 2.5 cm thick.
- Two plane implant leads to low dose region midway between the planes.
- Tumour shape: sphere, cube and cylinder.
- Table provided is valid, where L, B & H are equal.
- Elongation factor: applied when L, B & H are ≠
- Volume is divided into two parts: rind and core.

  sph: rind → shell/surface, cub: rind → six faces, cyl: rind → belt &2 ends
- Total amount of radium activity is divided into eight equal parts: sphere:

  Shell – 6 parts, core - 2 parts
  Cylinder: Belt - 4 parts, core - 2 parts, each end - 1 part

  Cuboid: Each side 1 part, core 2 parts

Elongation:	1.5	2.0	2.5	3.0
C.F:	3%	6%	10%	15%

VOLUME IMPLANT

Rules:

- Sources should be spaced evenly possibly.
- Separation between the two needles should not be more than 1.0 or 1.5 cm.
- Cylindrical implant: belt should not be more than eight needles, the core not less than four.
- In certain cylindrical cases it is impossible to close either one end or both ends. In such cases, the volume as determined by the active length of the belt, must be reduced by 7.5 percent for each open ends.

SYSTEMS OF IMPLANTS

- Paterson-Parker (Manchester) system
- Quimby system (Memorial) system
- Paris system – Pierquin, Chassagne , Dutreix and Marinello
- Computer System

PARAMETERS	MANCHESTER	QUIMBY	PARIS	COMPUTER
Linear strength	Variable	Constant	Constant	Constant
Source distribution	Planar implant:(periphery) Area <25 cm- 2/3 Ra; 25-100 cm- ½ Ra; >100 cm- 1/3 Volume implant::Cylinder:belt-4 parts,core-2,end-1 Sphere:shell-6,core-2 Cube :each side-1,core-2	Uniform Uniform	Uniform Line sources parallel planes	Uniform Line sources Parallel or cylinderic volumes
Spacing line source	Constant approx. 1 cm apart from each other or from crossing ends	Same as Manchester	Constant, Selective Separation 8-15 mm	Constant Selective
Crossing needles	Required to enhance dose at implant ends	Same	Crossing needles not used;active length 30-40% longer	Crossing needles not used;active length 30-40% longer

CLASSICAL SYSTEM COMPONENTS

- DISTRIBUTION RULES: given a target volume, distribution rules determine how to distribute RA sources & applicators in & around target volume
- DOSE SPECIFICATION & IMPLANT OPTIMIZATION CRITERIA: Each system has a definition of prescribed dose
- Above criteria determine dose homogeneity, normal tissue sparing, no. of catheters implanted & margins around target
- DOSE CALCULATION AIDS: Older systems used tables that give dose delivered per mg Ra-Eq-hr as a function of treatment volume or area
- Recent Paris system uses computerized treatment planning to relate absorbed dose to source strength & treatment time

FEATURES	MANCHESTER SYSTEM
DOSE & DOSE RATE	6000-8000 R in 6-8 days (1000 R/day; 40 R/hr)
UNIT / USE OF RADIUM	mg Ra hr – defined as amount of radium to give specified dose in 1 hr
DOSE SPECIFICATION CRITERA	Effective minimum dose 10% above absolute minimum dose
LINEAR ACTIVITY	Variable: 0.66 and 0.33 mg Ra Eq/ cm

QUIMBY SYSTEM

- Developed by Edith Quimby et al
- Dose 5000-6000 R in 3-4 days
- Uniform linear activity sources are distributed uniformly over the area or volume to be treated.
- This will lead to non-uniform dose distribution, higher in the central region.

QUIMBY SYSTEM

- Equal linear intensity (mg RaEq/cm) needles distributed uniformly (fixed spacing) in each implant, although spacing selected in 1-2 cm range acc. to implant size
- Quimby tables (Nomogram) give mg RaEq-hr to deliver stated exposure of 1000 R as function of T.V. or area (5000-6000 R over 3-4 days; 60-70 R/hour)
- No clear description of rules for distributing Ra needles
- Crossing recommended; peripheral needles placed on or beyond T.V. boundaries
- Dose specification criteria inconsistent

NOT RECOMMENDED FOR CLINICAL USE

PARIS SYSTEM

RADIOACTVE SOURCES

- Rectilinear/parallel -arrangement so that centers are located in the same plane which is perpendicular to the direction of sources-
- CENTRAL PLANE
- Equidistant
- Linear activity-uniform and identical
- Source geometries
  - Linear- single-plane implants
  - Squares/Equilateral triangles- two plane implants

PARIS SYSTEM

Basal dose rate and reference dose rate

- Basal Dose Rate (BD), is defined as the arithmetic mean of the local minimum doses midway through an array of equally spaced ribbons for ***single plane implants*** **. For *double plane implants*,** the basal dose rate is the dose rate in the central cross-sectional plane at the intersection of perpendicular bisectors projected from the side of the triangle for **triangular** arrangement and at the geometric centre for **square** arrangements.

- Reference Dose Rate (RD) which is equal to 85% BD is the dose rate used for dose prescription.

Ref. Dose Rate (RD) = 0.85 * BD_{ave} ; where $BD_{ave} = \sum BD(i) / n$

FEATURES	PARIS SYSTEM
DOSE AND DOSE RATE	6000 -7000 cGy in 3-11 days
DOSE PRESCRIPTION POINT	Average of the minimum doses in the region defined by the source
REFERENCE DOSE & DOSE GRADIENT	85 % of the BASAL DOSE 15 % between the Reference dose and the Basal dose
RA SOURCE PLACEMENT	Reference isodose volume covers the treated volume

TEMPORARY IMPLANTS

- Radioactive sources removed after desirable dose has been delivered
- Rigid stainless steel needles/flexible Teflon / nylon guides/plastic tubes
- Preloaded/After loaded

PERMANENT IMPLANTS

- Pre loaded – rigid needle eg. Ra^{226}, Cs^{137}
- After loaded – Manual/ Remote
- **Advantages**
  - Flexibility of implant design
  - Reduction of radiation exposure levels resulting in more accurate placement of needles and guides
  - Less accessible sites
  - Cont. ultra low dose rate>Max biological effectiveness
  - Better tissue heal
  - Better effect in slow and radio resistant tumors
  - Improved mobility
- **Disadvantages**
  - Environmental issue
  - Dosimetric uncertainties > Later part of T/T becomes less effective
  - Source displacement
  - Large tumor > Difficult procedure and geometry
  - Radio biologically less effective for rapidly proliferating tumors

COMPUTER BASED SYSTEMS

- Implant system evolved through use of computers
- Implantation rules: Sources of uniform strength
- Spaced uniformly (1-1.5 cm), larger spacing for larger implants to cover entire T.V.
- Active length 30-40% longer than Target length as ends uncrossed
- T.V.: sufficient safety margins; peripheral sources implanted on outer surface
- Dose specified by isodose surface that surrounds target
- Whole planning with help of computers

COMPUTER BASED SYSTEMS

- Possible to preplan implants & complete isodose distribution corresponding to final source distribution
- Rapid & fast; helps modify implant
- Isodose patterns can be magnified & superimposed on implant radiograph
- Localization of sources:
  - Orthogonal Imaging method
  - Stereo-shift method
  - CT
- Dose Calculation:
  - No. of milligrams or millicurie in implant
  - Location of each source with respect to dose calculation point
  - Type of isotope being used
  - Filtration of the encapsulation

DOSE COMPUTATION

- Dose calculation Formalisms' (AAPM TG 43 algorithm)
  - Use Sievert Integral directly
  - Precalculated dose tables
    - For Radium & other long lived sources: Dose rates in form of isodose curves
    - For Iridium & relatively short lived implants: Computer calculates cumulative dose with decay correction

INTRACAVITARY THERAPY

- Radioactive sources are placed in a existing cavity usually inside a predefined applicator with special geometry
- Uses:
  - Cervix
  - Endometrium
  - Vagina
  - Maxilla
  - Nasopharynx

PARIS TECHNIQUE

- Small quantity of radium.
- Longer period of treatment about 6-8 days.
- Total amount of radium for application = 8000 mg - hr.
- A part of the radium is applied in the uterine canal and the rest is divided into two halves and placed in two colpostats (cylindrical applicators made of cork or "sorbo rubber") applied high up in the vaginal vault.
- Colpostats: Separated laterally by a spring.
- Modified by the Manchester group, known as Manchester System.

STOCKHOLM TECHNIQUE

- Devised by Forsell and Heyman
- Large amount of Ra & Shorter treatment time.
- Applicators: Stainless steel (L: 53 to 70 mm and Φ 7 mm)
- Larger diameters: ≤13 mm used, to avoid excessive dose to the uterine wall.
- Permanently loaded:
  - Tandem: 53 to 88 mg of Ra & Designed to provide 75 R/hr (of the order) dose rate at 2 cm from the centre of the applicator.
  - Ovoid: Vary in shape and size and contain 60-80 mg radium.
- Treatment time: Generally about 27 hrs. X 2 sitting (3 weeks interval)

MANCHESTER SYSTEM

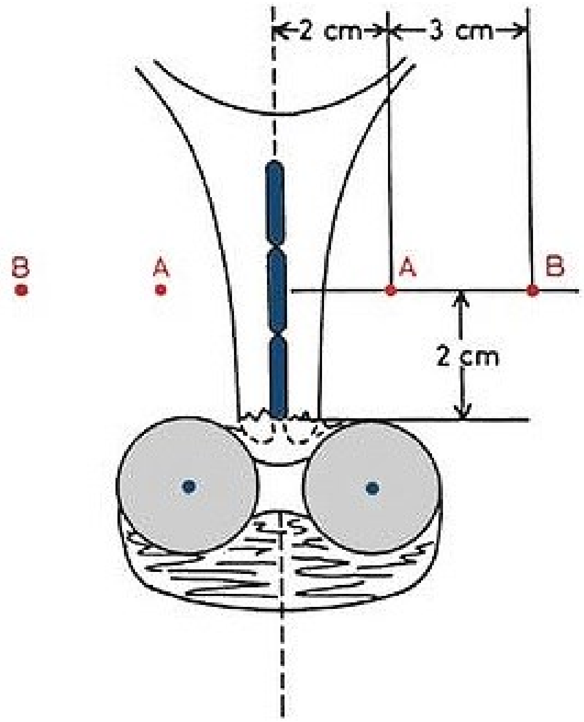
- Main feature: selection of reference point in the pelvic cavity for dose specifications and dose specification in terms of R.
- Criteria:
  - Anatomically comparable from patient to patient.
  - Not highly sensitive to small and clinically insignificant alterations in applicator position.
  - Allow for correlation of dosage and clinical effects.
- Source Loading:
  - 20 and 35 mg of Radium in Intrauterine applicators
  - 15 and 25 mg of Radium in vaginal ovoids.

Point A

- Anatomical position: chosen in the paracervical tissues, 2 cm lateral to the central canal of the uterus and 2 cm above the vaginal vault . Anatomically point A lies in the region where the' uterine artery crosses the ureter. In fact point 'A' lies on the apex of a triangle formed by the uterine canal, uterine artery and ureter (called the 'paracervical triangle').

- Significance:
- This region is important in respect of tissue tolerance and is often the site of early infiltration and hence not to be under-dosage.
- Paracervical Triangle where initial lesion of radiation necrosis occurs
- Area in the medial edge of broad ligament where the uterine vessel cross over the ureter

- **Point B**
- Anatomical position: 3 cm lateral to point A. In an average patient, point B lies close to or on the pelvic wall.
- Significance:
- Give an indication of the fall-off of dose in the pelvic region.
- The dose rate at point B is very useful for supplementary external beam irradiation.
- Rate of dose fall-off laterally
- Imp. Calculating total dose-Combined with EBRT
- Proximity to important OBTURATOR LNs
- Same level as point A but 5 cm from midline
- Dose ~20-25 % of the dose at point A


2 cm
3 cm
B
A
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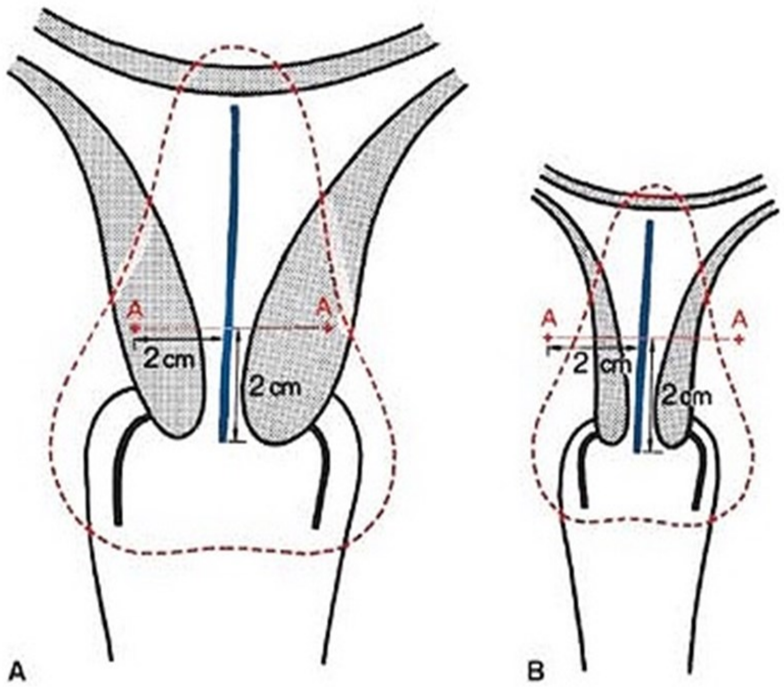
2 cm


A
A
2 cm
2 cm
A
A
A
2 cm
2 cm
B

LOADING

- In order that point A receives same dosage rate no matter which ovoid combination is used ,it is necessary to have different radium loading for each applicator size
- Dose rate 57.5 R/hr to point A
- Not more than 1/3 dose to point A must be delivered from vaginal radium

TUBE TYPE	LENGTH	TUBES	RADIUM (mg)	UNITS (FUNDUS to CX)	LOADING TUBES (mg)
LARGE	6	3	35	6-4-4	15-10-10
MEDIUM	4	2	25	6-4	15-10
SMALL	2	1	20	8	20
VAGINAL OVOIDS		TUBES	RADIUM (mg)	UNITS	LOADING TUBES(mg)
LARGE		3	22.5	9	10-10-5 or 20/25
MEDIUM		2	20	8	20
SMALL		1	17.5	7	10-5-5 or 20/15

ICRU 38

- Compare different treatment techniques and evaluate their respective merits
- Compare the present concepts with historical series
- Derive new clinical and radiobiological data

Dosimetric information for reporting

- Complete description
  - Technique
  - Time-dose pattern
- Treatment prescription
- Total Reference Air Kerma
- Dose description
  - Prescription points/surface
  - Reference dose in central plane
  - Mean central /peripheral dose
- Volumes: Treated/ point A/ reference volume
- Dose to Organs at Risk : bladder, rectum

REFERENCE VOLUME

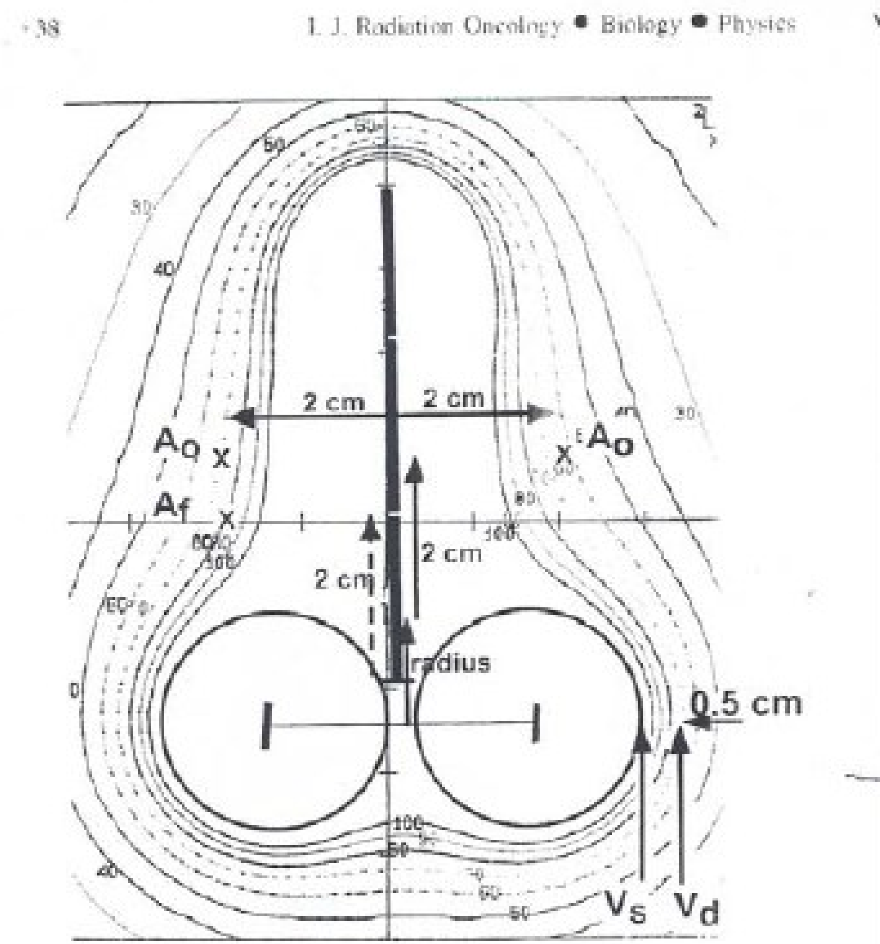
- Dimensions of the volume included in the corresponding isodose
- The recommended dose 60 Gy
- Defined as the volume encompassed by reference isodose surface which is 60 Gy of adsorbed dose for low dose rate therapy.
- When the BT is combined with EXBT then reference Isodose will be 60Gy minus the dose delivered by EXBT.
- For MDR and HDR, the therapist has to decide the dose level, which he/she believes to be equivalent to 60 Gy of LDR.
- Volume encompassed by reference Isodose surface. Absorbed dose of 60 Gy is accepted as the reference dose level for low dose rate therapy.

REFERNCE VOLUME

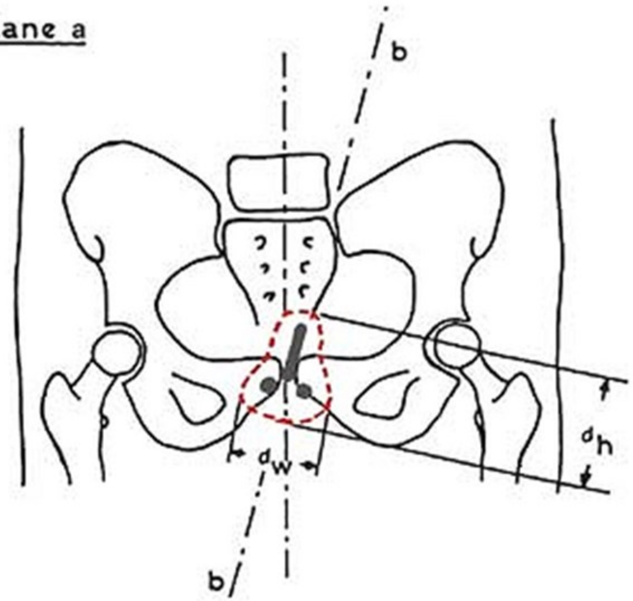
- When intracavitary therapy is combined with external beam therapy, the difference between 60 Gy and the dose delivered by external beam therapy is the reference dose level.
- For medium or high dose rate therapy, the therapist has to decide the dose level, which he/she believes to be equivalent to 60 Gy of LDR.

DESCRIPTION OF REFERNCE VOLUME

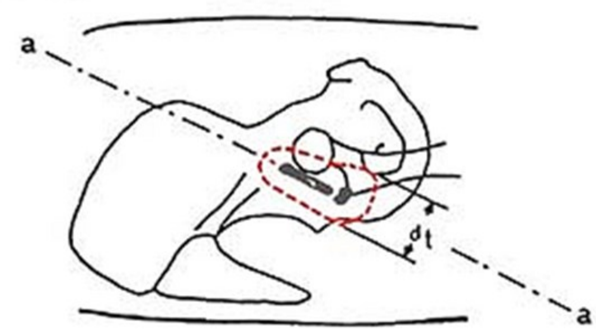
- Height (dh) is the maximum dimension along intrauterine source measured in the oblique frontal plane containing uterine sources.
- Width (dw) is the maximum dimension perpendicular to intrauterine sources measured in the same oblique frontal plane.
- Thickness (dt) is the maximum dimension perpendicular to intrauterine source measured in the oblique sagittal plane



Plane a



Plane b

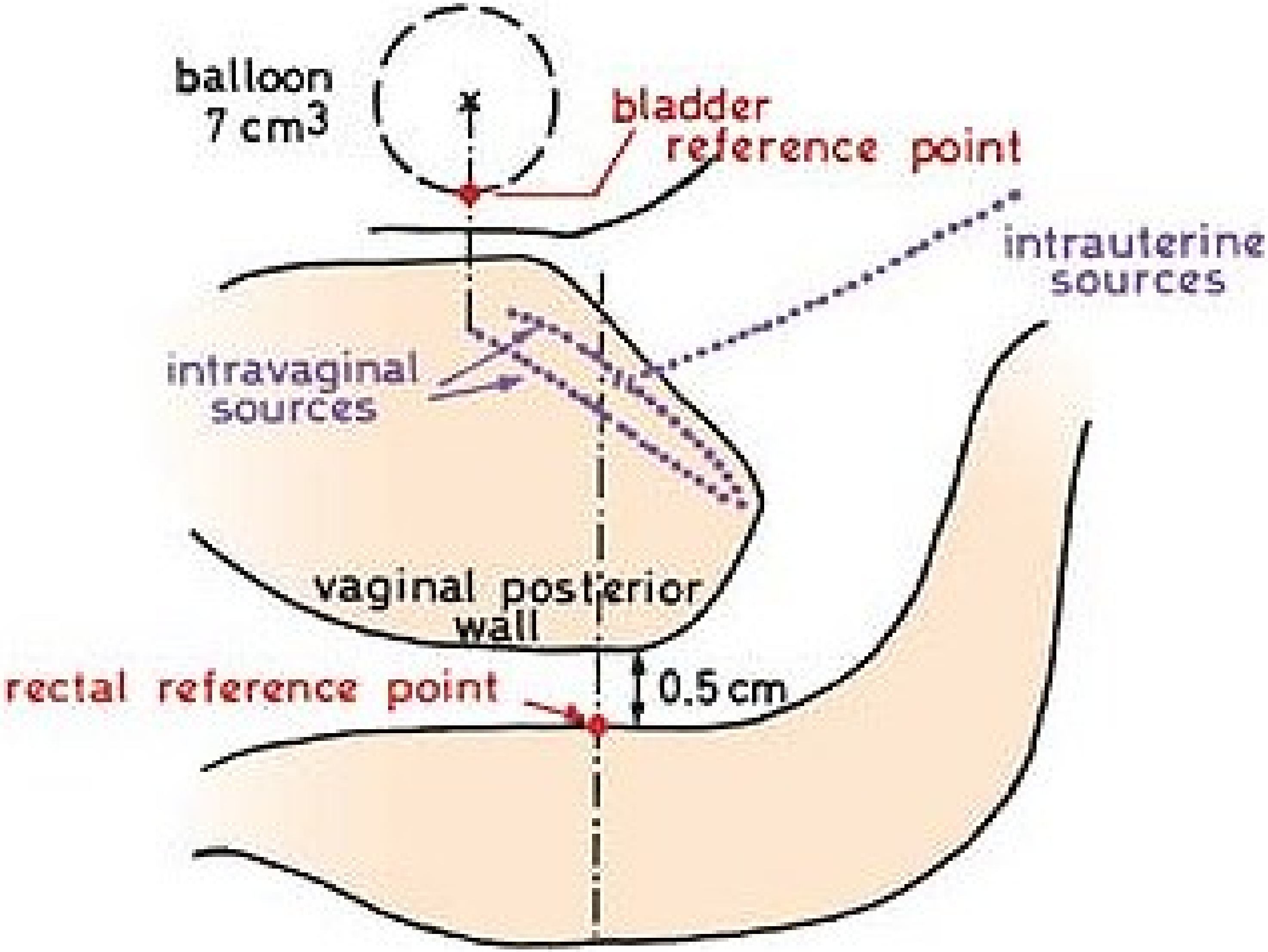


REFERENCE POINTS (ORGANS AT RISK)

- BLADDER POINT
- RECTAL POINT
- LYMPHATIC TRAPEZOID OF FLETCHER
- LOW PA, LOW COMM.ILIAC LN & MID EXT ILIAC LNs
- PELVIC WALL POINTS
- DISTAL PART OF PARAMETRIUM & OBTURATOR LNs

BLADDER AND RECTAL POINTS

- The dose to bladder and rectum may be calculated by visualizing the organs, in radiograph with respect to the position of active sources.
- To visualize bladder, in radiograph, a radio-opaque dye is injected into it.
- At the centre of the balloon in A-P radiograph.
- On the lateral radiograph, the bladder point is taken on a line drawn anteroposteriorly through the centre of the balloon, at the posterior surface.
- On the frontal radiograph, at the midpoint of the ovoid sources.
- Rectal point is taken on a line drawn from middle of the ovoid sources, 0.5 cm below posterior vaginal wall at the level of lower end of uterine sources.
- To visualize vaginal wall radio opaque gauze packing is used in the vagina. Alternatively rectal dose may be measured.

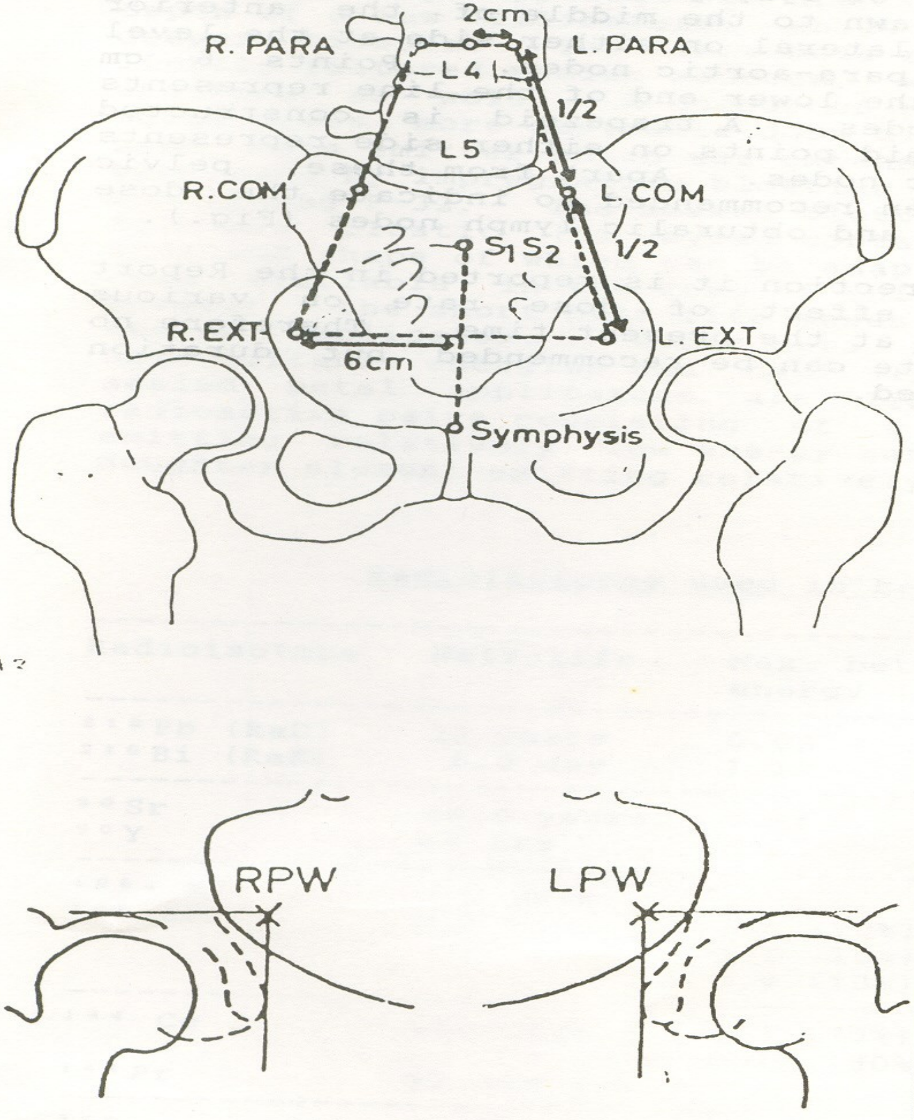


balloon
7 cm3
bladder
reference point
intrauterine
sources
intravaginal
sources
vaginal posterior
wall
rectal reference point
0.5 cm

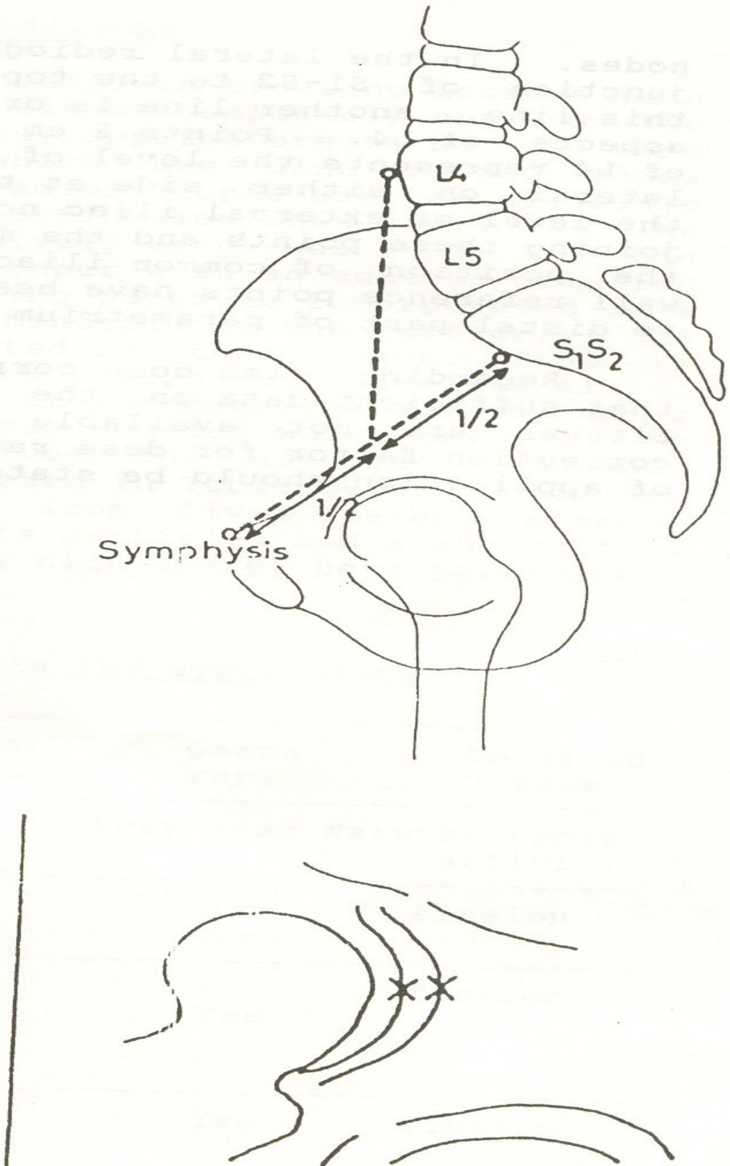
REFERENCE POINTS RELATED TO BONY STRUCTURES

- Para-aortic nodes
- Common iliac nodes
- External 'iliac nodes

In the lateral radiograph a line is drawn from the junction of S1-S2 to the top of symphysis. From the middle of this line, another line is drawn to the middle of the anterior aspects of L4. Points 2 cm lateral on either sides at the level of L4 represents the level of para-aortic nodes. Point 6 cm lateral on either side at the lower end of the line represents the level of external iliac nodes. A trapezoid is constructed joining these points and the middle points on either side represent the level of common iliac nodes. Apart from these, pelvic wall reference points have been recommended to indicate the dose to distal part of parametrium and obturator lymph nodes.



AP X-RAY FILM



LATERAL X-RAY FILM

- TREATED VOLUME
  - Pear and Banana shape
  - Received the dose appropriate to achieve the purpose of the treatment, e.g., tumor eradication or palliation, within the limits of acceptable complications
- IRRADIATED VOLUME
  - Volumes surrounding the Treated Volume
  - Encompassed by a lower isodose to be specified, e.g., 90 – 50% of the dose defining the Treated Volume
  - Reporting irradiated volumes may be useful for interpretation of side effects outside

OPTHALMIC PLAQUE THERAPY

- Treatment of eye cancer.
- Common tumour: Choroidal melanoma (adults)/ Retinoblastoma (children)
- Plaques:
  - Sources are permanently loaded
  - Sealed sources are temporarily inserted

Radioisotopes used in beta ray applicators

Radioisotope	Half-life	Max. beta energy (Mev)	Gamma Rays	Obtained From
^{90}Sr ^{90}Y	28.0 yrs 64 hrs	0.54 2.25	None None	Fission
^{106}Ru ^{106}Rh	1.0Yrs 0.5 min	0.04 3.5 (70%) 3.1 (10%) 2.4 (10%)	Yes	Fission
^{32}P	14 Days	1.7	No	Activation
^{125}I	60 days		Yes	Activation

ENDOVASCULAR/INTRAVASCULAR BRACHYTHERAPY

- Management of Obstruction or Blockage in the blood carrying arteries.
- Modes: By pass surgery/ PTCA with stent.
- Drawback of By pass surgery:
  - Patient trauma
  - More failure cases
- Coronary arteries: Related with heart
- Peripheral arteries: Other than heart
- E.V./I.V. brachytherapy: Prevention from the re-stenosis.
- Re-stenosis: Re blockage of the arteries.

ENDOVASCULAR/INTRAVASCULAR BRACHYTHERAPY

- Reasons of Blockage:
  - Injury due to PTCA procedure
  - Thrombosis
- Stents/Radioactive stents
- Sources Used: Gamma emitters and Beta emitters
- Gamma Emitters: Ir-192, I-125, Pd-103
- Beta Emitters: Sr-90/Y-90, P-32, W-188/Re-188

Radioisotopes for vascular brachy therapy

Element	Isotope	Emission	Half Life	γ ave (MeV	βmax / βave (MeV)
Iridium	Ir-192	Gamma	74d	0.38	
Phosphorus	P-32	Beta	14d		1.7 / 0.69
Strontium (Yttrium)	Sr-90 / Y-90	Beta	28y 64h		2.28/ 0.93
Rhenium	Re-188/ Re-186	Beta Gamma	17h 91h		2.12 / 0.78 1.08 / 0.32
Tungsten (Rhenium)	W-188 / Re-188	Beta	69.4d 17h		2.12 /0.78

RADIATION PROTECTION

- No source lose
- Time
- Distance
- Shielding
- Practice
- No spillage (in case of liquid)
- Proper guide lines in case of emergency

THANK YOU.