

Brachytherapy in Carcinoma Cervix

Conventional Methods

Dr. S.C. Sharma
Professor & Head



Department of Radiotherapy,
RCC, PGIMER, Chandigarh

INTRACAVITARY BRACHYTHERAPY

Brachytherapy plays a sheet anchor role in the management of carcinoma cervix and is responsible for most of the cures.

Brachytherapy is used in form of intracavitary application where radioactive sources are placed in uterine cavity and vagina, usually inside a predefined applicator with special geometry.



INTRACAVITARY BRACHYTHERAPY

Advantages:

1. High dose in short time.

Cervix : 20,000-25,000 cGys.

Uterus : 20,000-30,000 cGys.

Vagina : 10,000 – cGys.

2. Control rate higher.

3. Sharp fall of dose, less normal tissue damage.

4. Less late radiation morbidity.

5. Preservation of normal anatomy.

6. Better sexual functional life.



Brachytherapy in Carcinoma Cervix History

1898 : Discovery of radium by Marie Curie in Paris.

1903 : Margarat Cleaves in New York city and
Doderlein of Tubinge in Germany reported
treatment of carcinoma cervix with radium.

1908 : Intracavitary brachytherapy started in Vienna

1910 : Intracavitary brachytherapy started in Stockholm



Brachytherapy in Carcinoma Cervix History

1912 : Intracavitary brachytherapy started at Paris.

1912 : Gosta Forssell of Stockholm reported 24 cases of carcinoma cervix treated with radium.

1913 : Abbe of New York reported long term control of carcinoma cervix – 8 years.

1930 : Todd & Meredith developed Manchester System in U.K.



Brachytherapy in Carcinoma Cervix

Methods

Three methods were developed between 1910 & 1930 for treatment of carcinoma cervix by intracavitary brachytherapy.

1. Stockholm Method : 1910
2. Paris Method : 1912
3. Manchester System : 1930



STOCKHOLM METHOD

- Fractionated course of radiation delivered over a period of one month.
- Three insertions each of 22 hours separated by 1-3 weeks.
- Intra-vaginal boxes Silver or gold
- Intrauterine tube -flexible rubber
- Unequal loading
 - 30 - 90 mg of radium in uterus
 - 60 - 80 mg in vagina
- Total prescribed dose -6500-7100 mg Ra
 - 4500 mg Ra contributed by the vaginal box
 - Dose rate-110R/hr or 2500mg/hr/#

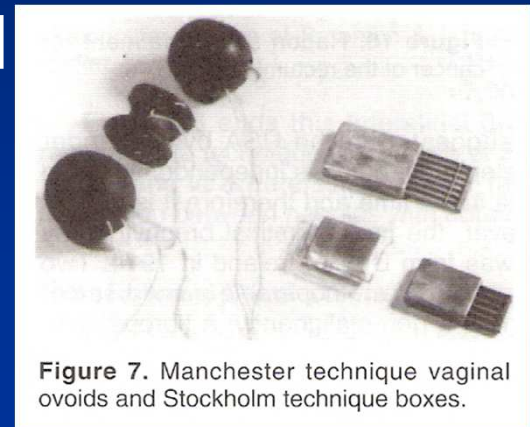


Figure 7. Manchester technique vaginal ovoids and Stockholm technique boxes.

PARIS METHOD

- Devised by Claudine Regaud & Antone Lacassagne – 1910.
- Single application of radium for 120 hours.
- Two cork colpostats (cylinder) with 13.3 mg radium in each and an intrauterine tube of silk rubber containing 33.3 mg of radium.
- **3 radioactive sources, with source strength ratio of 1:1:0.5 in uterus.**

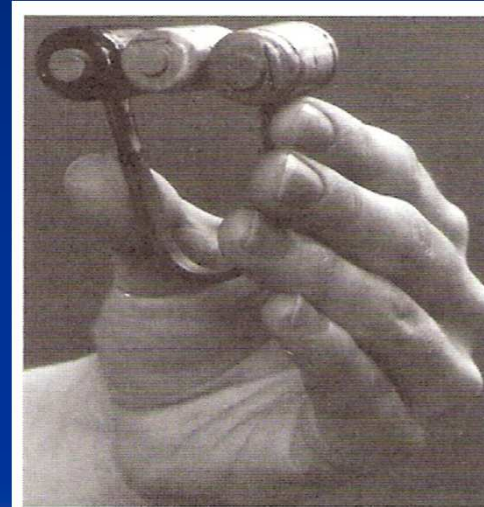


Figure 6. Paris technique cork applicators.

- Delivers a dose of 5500 mg-hrs of radium over a period of five days at dose rate of 45R/h.

DRAWBACKS OF PARIS AND STOCKHOLM SYSTEMS

- Long treatment time
- Discomfort to the patient
- No dose prescription



MANCHESTER SYSTEM

Developed by Todd & Meredith in 1930 and pioneered by Patterson & Parker.

NEED:

1. Recognized that unique dosage system was necessary for pelvis.
2. Abandoned previous dosage system of mg./hrs. in favour of roentgen unit.
3. Defined the treatment in terms of dose to a point.
4. Stressed the importance of constant dose rate.
5. Introduced reproducible technique which could aim at better tumour control and less radiation morbidity.



MANCHESTER SYSTEM

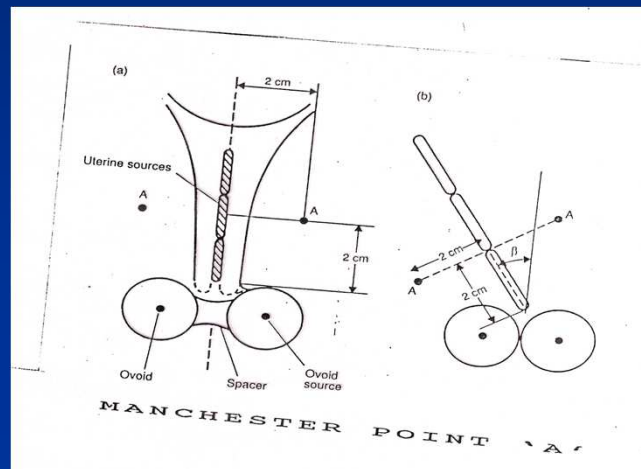
Defined two points – A & B

- where the dose is not highly sensitive to small alteration in applicator position
- Allows correlation of the dose levels with the clinical effects
- Designed a set of applicators and their loading which would give the same dose rate irrespective of the combination of applicators used
- Formulated a set of rules regarding the activity, relationship and positioning of the radium sources in the uterine tandem and the vaginal ovoids, for the desired dose rate .



POINT A

- 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
- The point A -fixed point 2cm lateral to the center of uterine canal and 2 cm above from the mucosa of the lateral fornix



POINT B

- Same level as point A but 5 cm from midline
- Rate of dose fall-off laterally
- Imp. Calculating total dose-Combined with EBRT
- Proximity to important obturator LNs
- Dose ~15-20 % of the dose at point A

POINT A & B

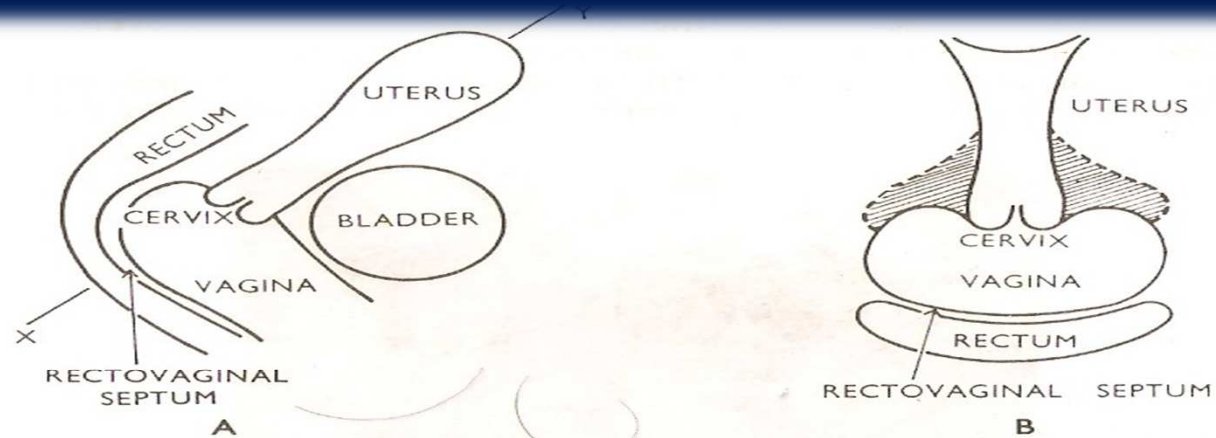


Fig. 434.—Anatomical relationships (diagrammatic) of the uterine cervix and neighbouring structures. A, Sagittal section. B, Plan in plane XY of A.

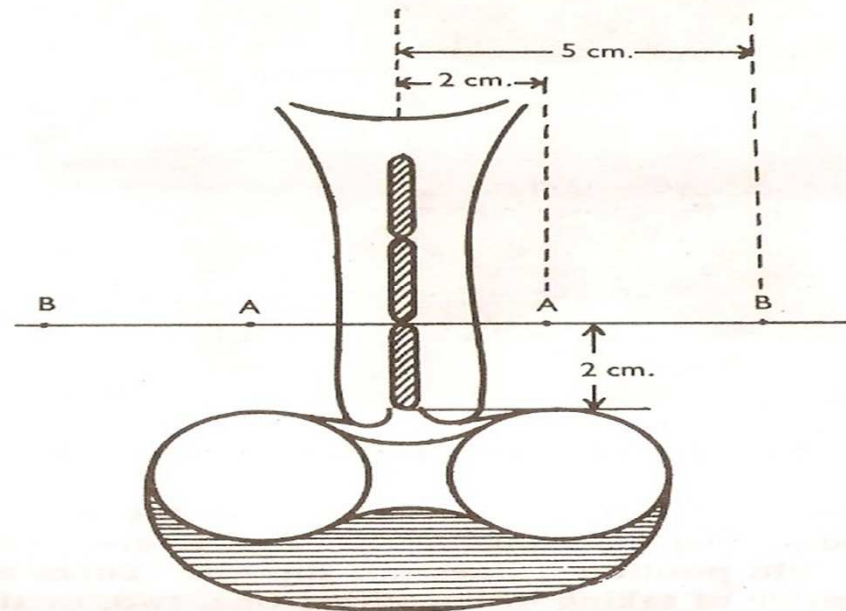


Fig. 435.—The positions of dosage points A and B.

MANCHESTER SYSTEM

This system is based on Paris technique.

1. It replaced vaginal colpostats with vaginal ovoids separated by spacer or washer.
2. Used differential loading in order to achieve constant dose rate.
3. Two applications of 72 hours each are given with 7-10 days period between two applications.
4. Dose of 8000 R is delivered at point A.

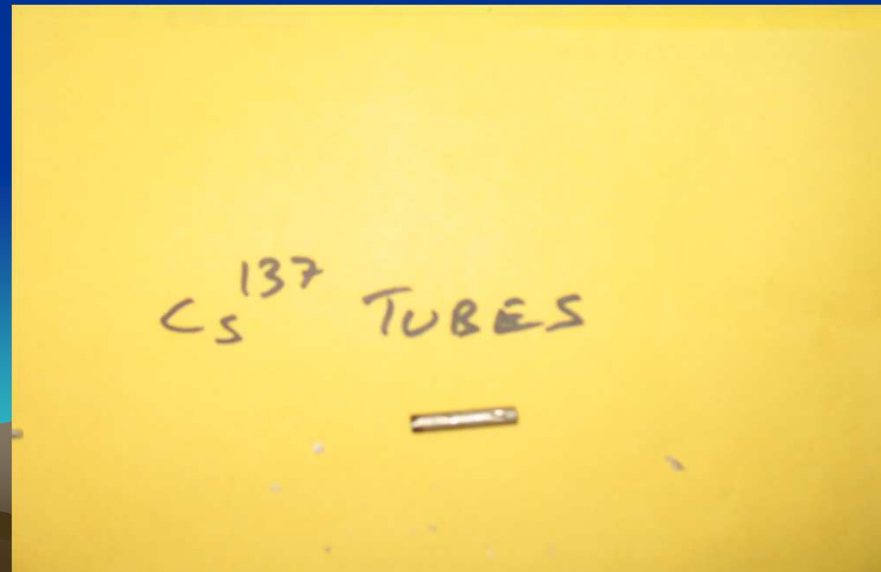
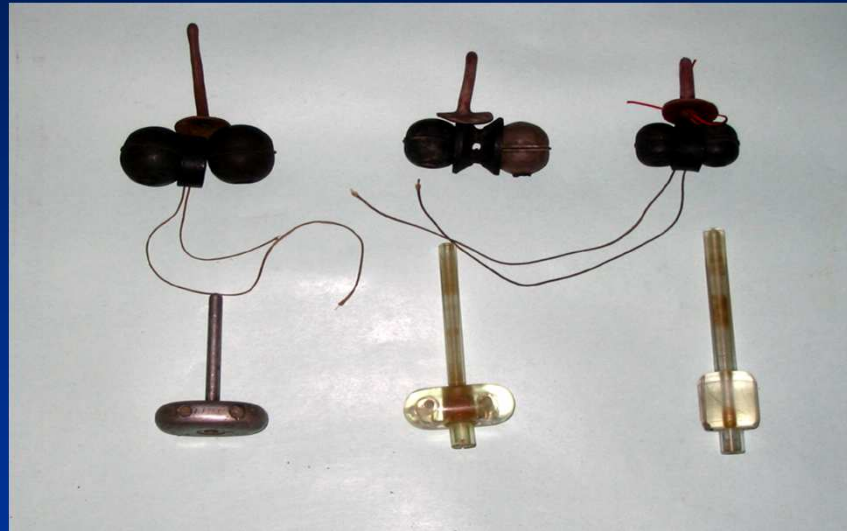
Present day brachytherapy practiced is based on Manchester System only at majority of centers.



Manchester Applicator

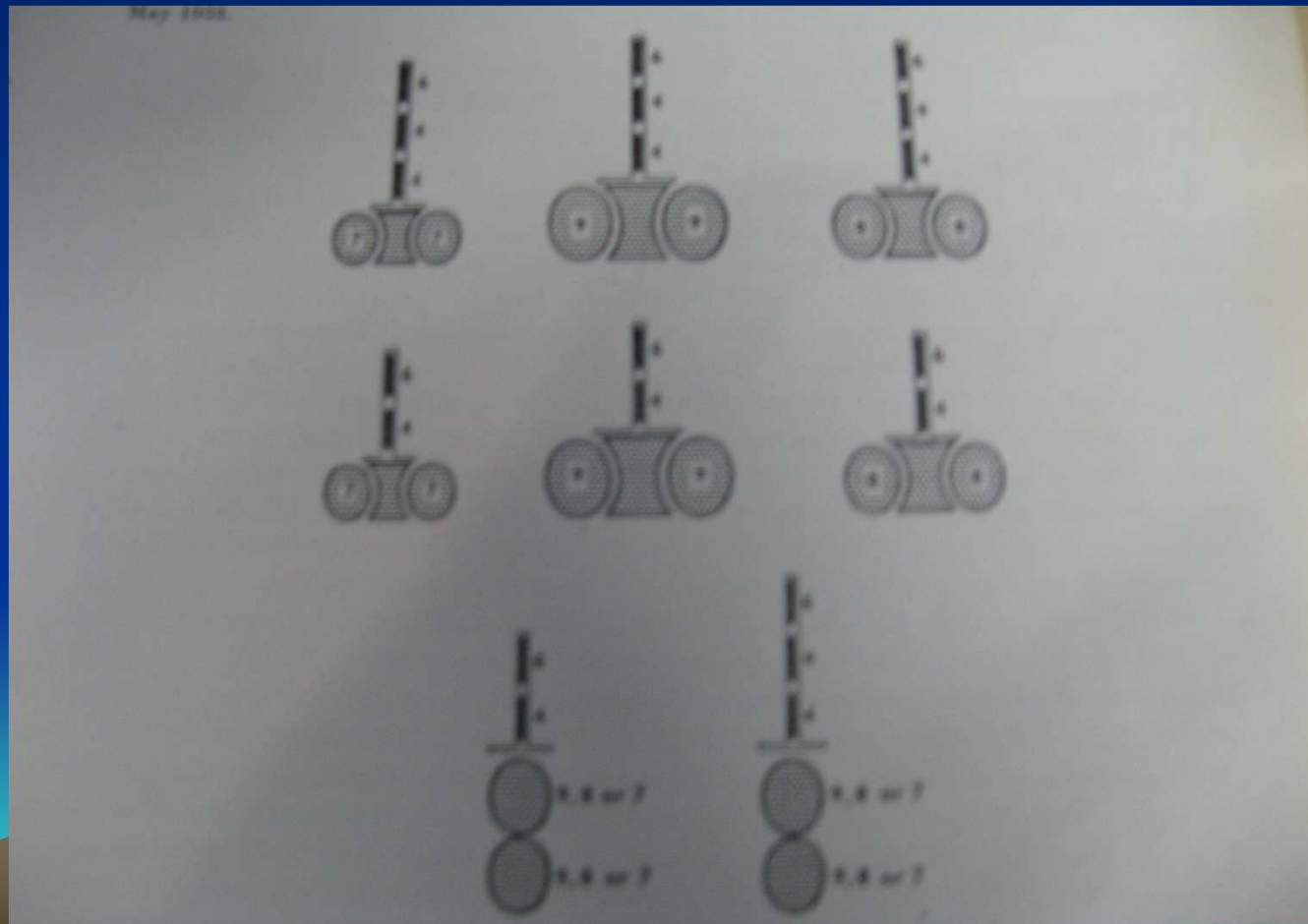


MANCHESTER SYSTEM PRELOADED APPLICATORS



Intracavitary Brachytherapy in Carcinoma Cervix

Different Combinations of Ovoids & Uterine Tandem



LOADING OF APPLICATORS

- In order that point A receives same dose rate, no matter which ovoid combination is used ,it is necessary to have different radium loadings 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



LOADING PATTERN

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

Manchester System

Advantages:

1. Loose system and therefore, can suit to any anatomical situation.
2. Well studied method and hence control rate and morbidity is well defined.
3. It is cost effective.



Manchester System

Dis-advantages:

1. Loose system and therefore, chances of slipping of ovoids and hence disturbed geometry and creation of cold and hot spots leading to high failure or increased morbidity.
2. Radiation hazard : being a preloaded system.

This led to development of fixed preloaded and afterloading applicators.



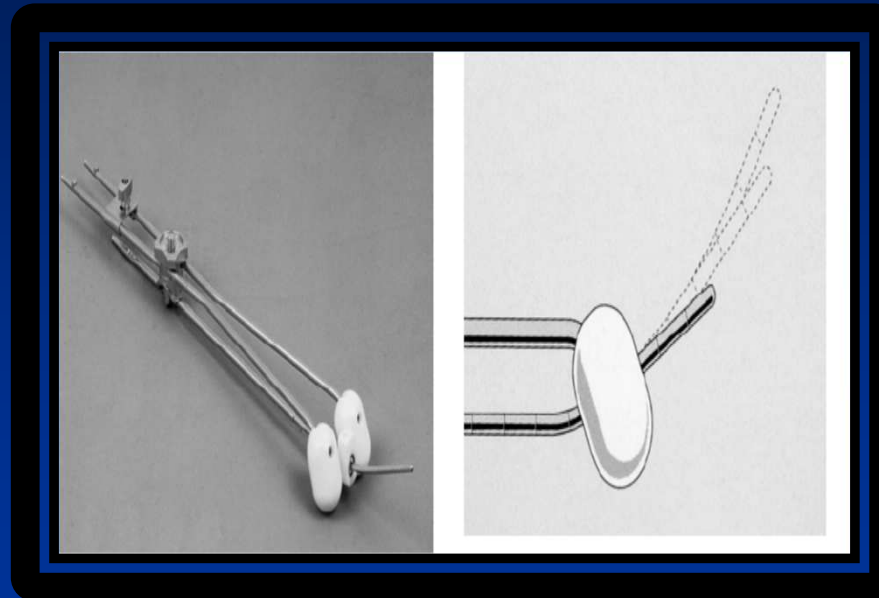
Fixed Intracavitary Applicators



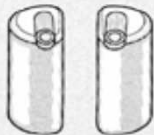
AFTER LOADING APPLICATORS

MANCHESTER

PGI



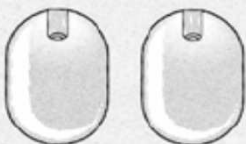
Half-ovoid pair, **mini**



Ovoid pair, **medium**



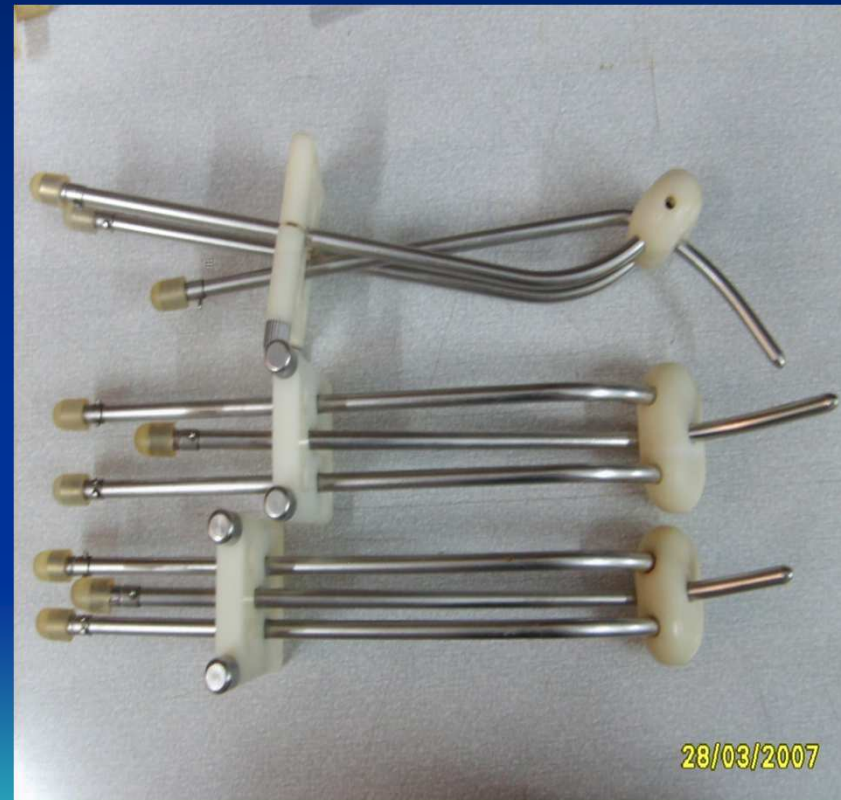
Ovoid pair, **small**



Ovoid pair, **large**

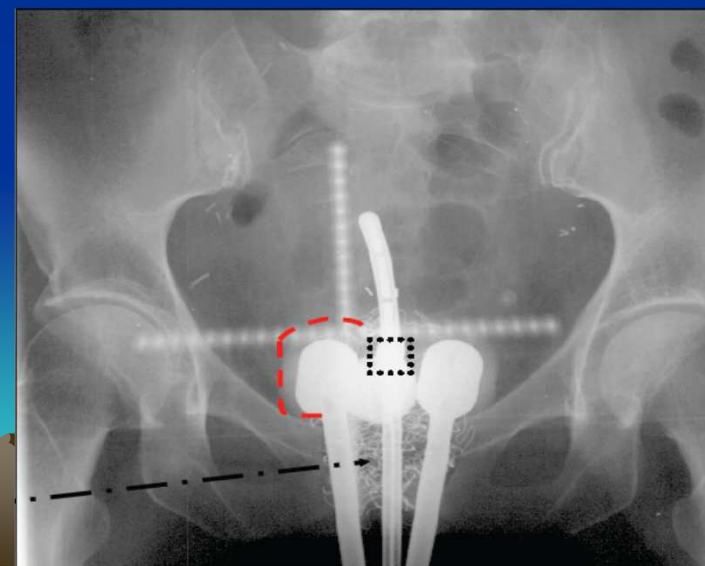
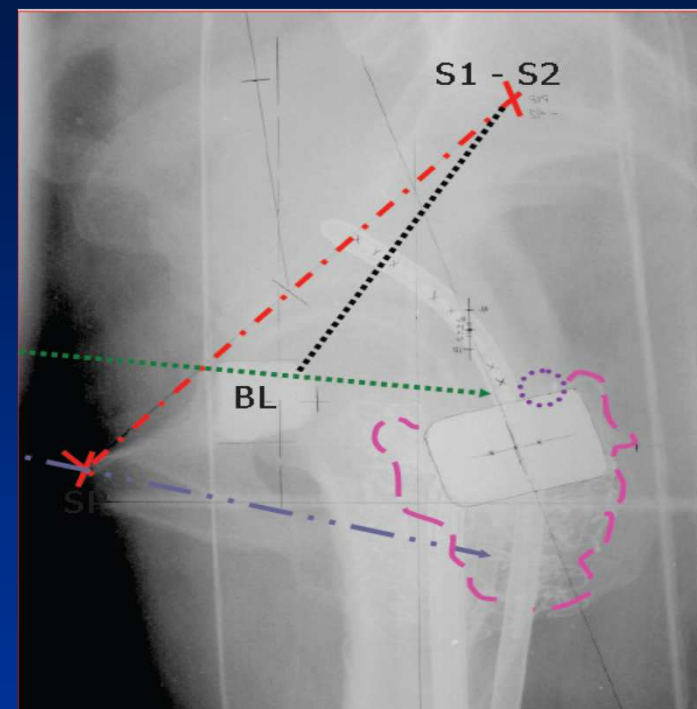


Remote Control Afterloading



IDEAL APPLICATION

- **Tandem**
 - 1/3 of the way between S1 – S2 and the symphysis pubis
 - Midway between the bladder and S1 -S2
 - Bisect the ovoids
- Marker seeds should be placed in the cervix
- **Ovoids**
 - against the cervix (marker seeds)
 - Largest
 - Separated by 0.5-1.0 cm
 - Axis of the tandem-central
- Bladder and rectum -should be packed away from the implant



GUIDELINES

- Largest possible ovoids
 - Lesser dose to mucosa
- Longest possible tandem (not > 6 cm)
 - Better lateral throw-off of dose.
- Dose to point A- 8000R
- Dose to uterine wall -30,000R
- Dose to the cervix : 20 – 25,000R
- Dose to vaginal mucosa-10,000R
- Dose to recto-vaginal septum- 6750 R
- Dose limitation
 - BLADDER <80 Gy
 - RECTUM <75 Gy

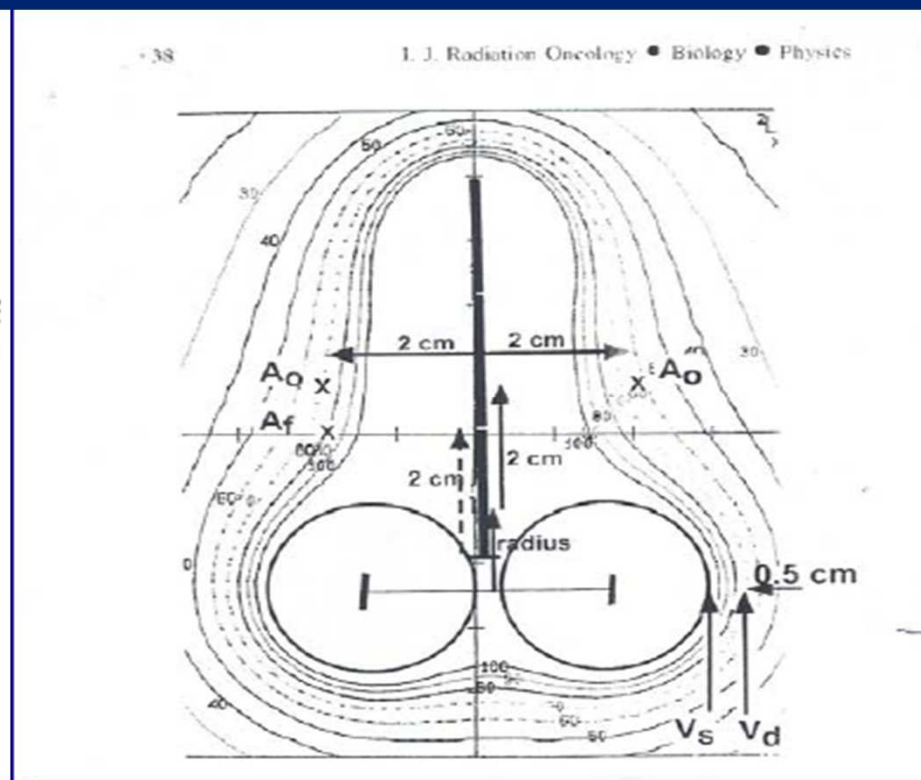
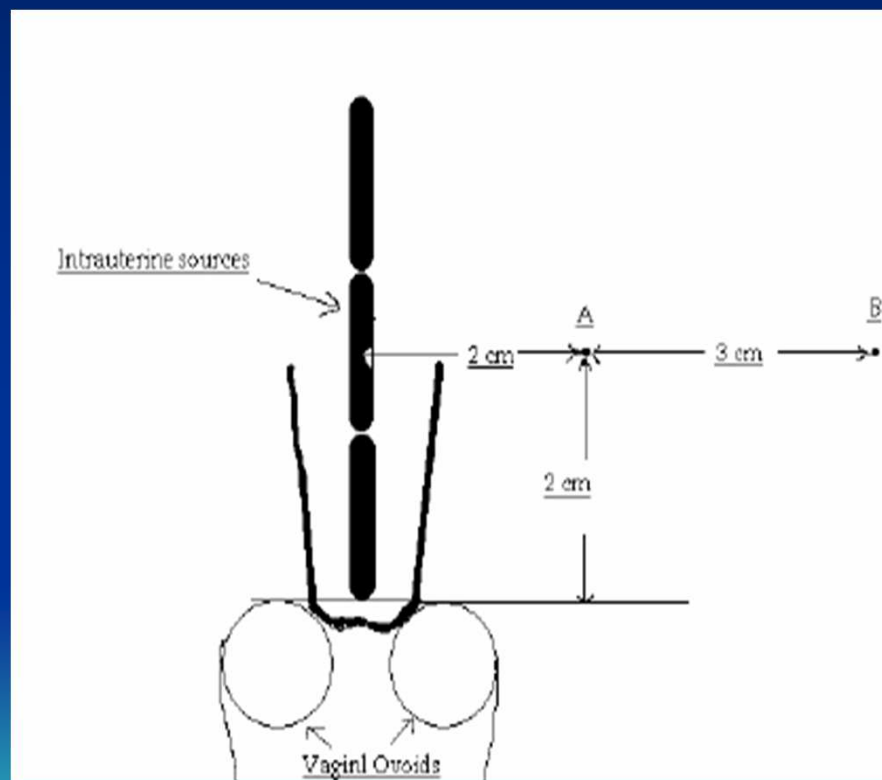
Brachytherapy in Carcinoma Cervix

Conditions to be met for successful
intracavitary therapy.

- Geometry of the radioactive sources must prevent under dosed regions on and around the cervix.
- An adequate dose has to be delivered to the para-cervical areas.
- Mucosal tolerance has to be respected.
- Optimal placement “Pear-Shaped” distribution delivering a high dose to the cervix and para-cervical tissues and a reduced dose to rectum and bladder.



CERVICAL BRACHYTHERAPY



Brachytherapy in Carcinoma Cervix

OPTIMAL PLACEMENT


1. Intracavitary application should be done under G.A.



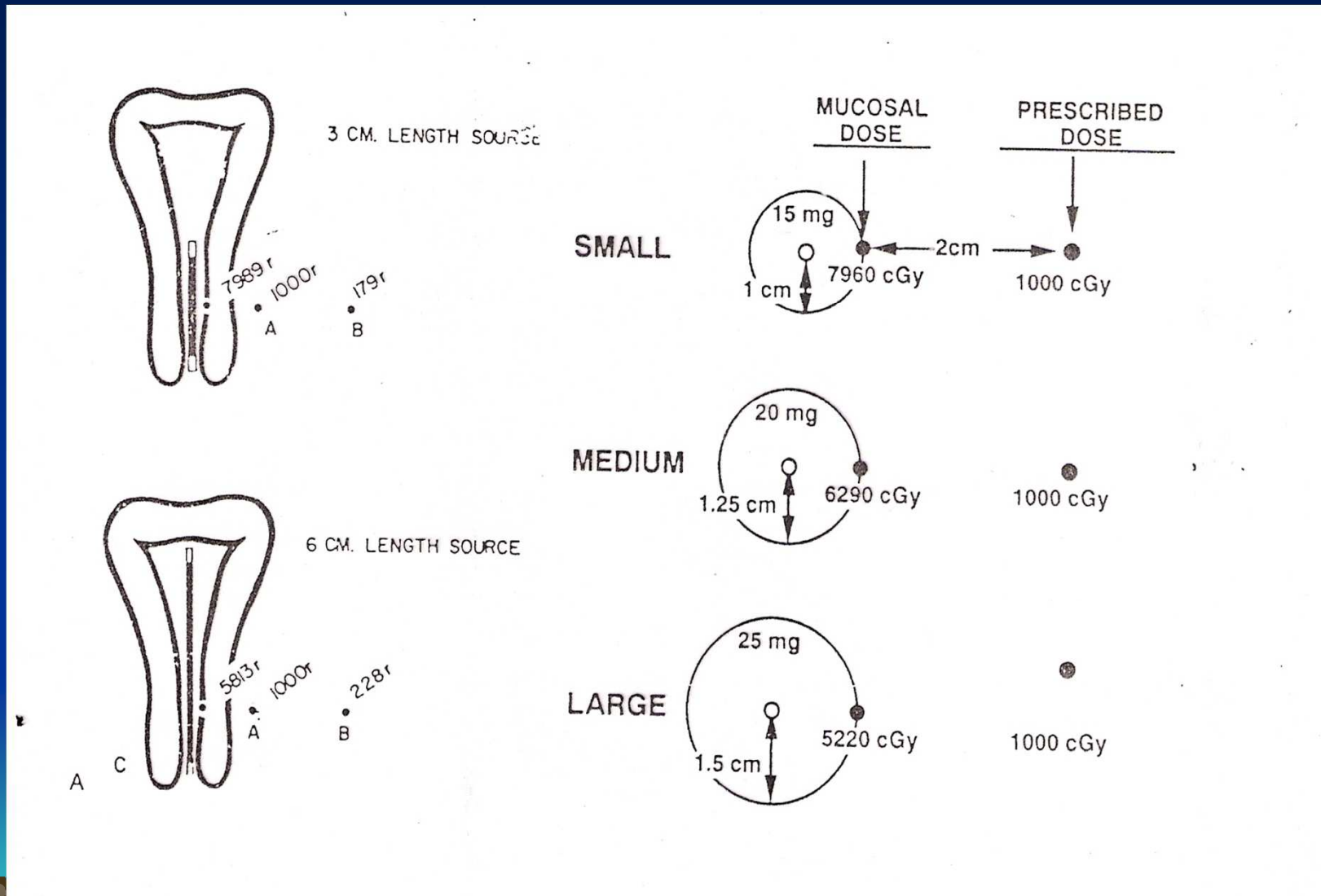
2. To optimize the lateral dose to parametrium, the tandem should be as long as anatomy permits but not more than 6 cm.
3. Tandem should be placed in a mid-position between sacrum and bladder.

Brachytherapy in Carcinoma Cervix

OPTIMAL PLACEMENT

4. To optimize the ratio between the dose at depth and the vaginal mucosal dose, the largest ovoids that permits adequate separation to admit the flange on the tandem between them without causing downward displacement of the ovoids should be used.
 5. The axis of the tandem should be equidistant from the ovoids and should bisect them on the lateral view.
 6. The flange of the tandem should be flushed against the cervix and ovoids should surround it.
 7. Care should be taken to adequately pack anteriorly and posteriorly.
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Intracavitary Brachytherapy in Carcinoma Cervix



Brachytherapy in Carcinoma Cervix

REPORTING OF INTRACAVITARY THERAPY IN GYNAECOLOGY

LIST OF DATA NEEDED

ICRU REPORT-38

- Description of the technique used.
- Total reference Air Kerma (cGy at 1 meter)
- Prescription of the Reference Volume – 60 Gys.
 - Dose level if not 60 Gys.
 - Dimensions of the reference volume



Intracavitary Brachytherapy in Carcinoma Cervix

CALCULATION OF POINT A DOSE

Meaning of point A Dose : **Calculation of point A Dose**

Minimum target dose : Minimum between DA_L & DA_R .

Maximum dose to the healthy tissue : Maximum between DA_L & DA_R .

Reference target dose : Average between DA_L & DA_R .



Brachytherapy in Carcinoma Cervix

REPORTING OF INTRACAVITARY THERAPY IN GYNAECOLOGY

LIST OF DATA NEEDED

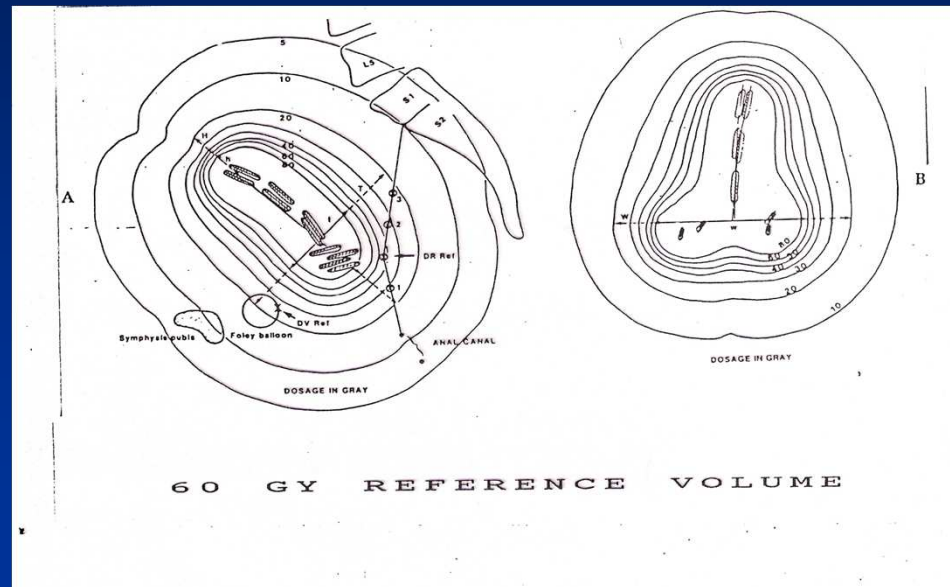
ICRU REPORT-38

- Absorbed dose at Reference points.
 - Bladder reference point.
 - Rectal reference point.
 - Lymphatic trapezoid.
 - Pelvic wall reference point.
- Time dose pattern.



- **REFERENCE VOLUME**

- Dimensions of the volume included in the corresponding isodose - 60 Gys.
- The recommended dose 60 Gys.



- **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

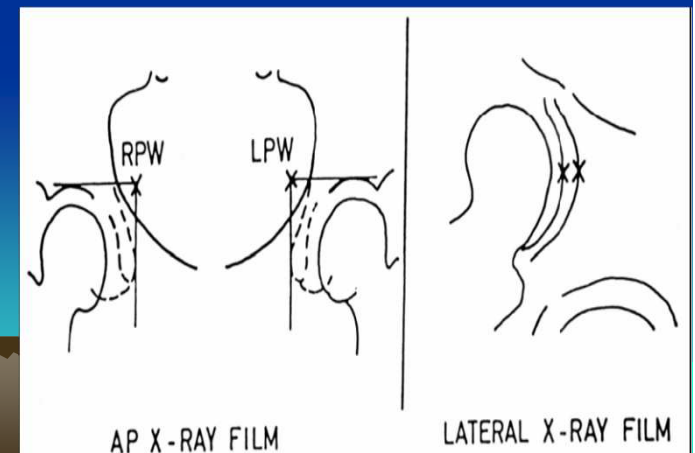
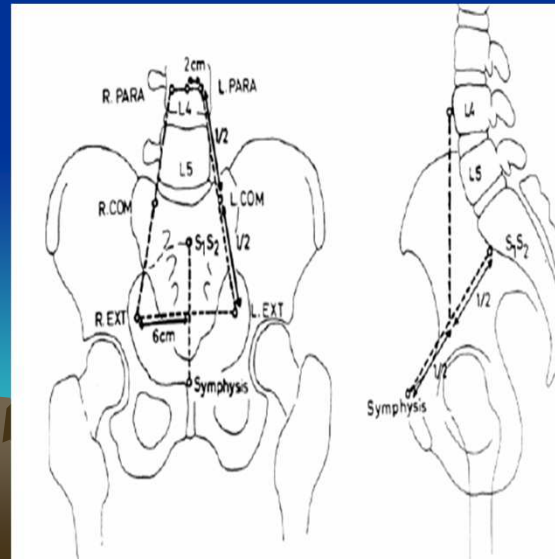
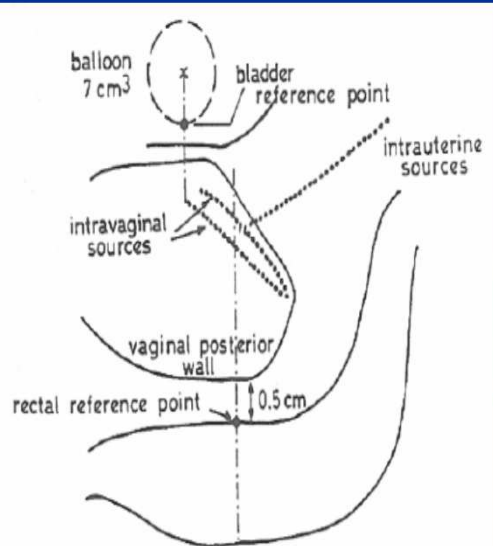
- **IRRADIATED VOLUME**

- 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.



ABS.DOSE AT REFERENCE POINTS

- 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



Brachytherapy in Carcinoma Cervix

RADIOTHERAPY TREATMENT CA.CERVIX

Central

Peripheral

Brachytherapy

Teletherapy

EARLY STAGE

Primary Treatment -ICBT

Boost –Ext.RT

LATE STAGE

Boost -ICBT

Primary Trt. –Ext.RT



DOSE SCHEDULE

Stage – I small & IIA

Brachytherapy Alone : 2 applications of 40 Gys.each

**Ext. RT + I/C
(small growth) : 2 applications of 40 Gys.and
35 Gys. each at point A.
: Ext. RT 35 Gys. With central
shield.**

Stage – I B large, IIB & III

**: Ext. RT 46-50 Gys.x 4½-5 wks.
: I/C one session 30-35 Gys.
at point A.**



Intracavitary Brachytherapy in Carcinoma Cervix

EFFECT OF ICBT ON SURVIVAL

Treatment	%age Survival at 5 years
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1. Ext.RT alone	36%
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2. Ext.RT+ICBT	67%
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3. Single ICBT	60%
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4. 2 or more ICBT	73%
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5. Dose at point A >65 Gys.	68%
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6. Dose at point A <65 Gys.	42%
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Brachytherapy in Carcinoma Cervix

RADIOTHERAPY TREATMENT

1. Proportion of ERBT increases with tumour bulk and stage.
2. Except for small tumours, ERBT precedes ICRT.
3. Two ICRT applications are better than one.
4. Para-central dose should be 75-80 Gy.
5. Pelvic sidewall dose should be 45-60 Gy.



Intracavitary Brachytherapy

Changing Dose Rates:

1968 : HDR brachytherapy was introduced with cathetrone containing Co-60 sources.

1982 : MDR brachytherapy was introduced with Selectron MDR using Cs-137 pallet sources.

Both these systems are replacing conventional low dose rate brachytherapy and at present HDR brachytherapy is being used with increasing frequency.



DOSE SCHEDULE

- LDR (<200cgy/hr)
 - 35-40 Gy at point A per session.
- MDR (200-1200cgy/hr)
 - 35-40 Gy LDR EQUIVALENT at point A per session.
- HDR(>1200cgy/hr)
 - 9 Gy per # for 2-5 Frs.
 - 7 Gy per # for 3-6 Frs. at point A



POST OP/ VAULT BRACHYTHERAPY

- Vault RT
 - No residual disease
 - 8500 cGy at 5mm from the surface of the vault
 - 2 sessions 1 week apart
 - Residual disease
 - CTV of 2 cm given to gross tumor and the prescription of 8500cgy encompassing the whole CTV is made
 - 2 sessions 1 week apart
- Mostly after XRT



INTRACAVITARY BRACHYTHERAPY

- **CONTRAINDICATIONS**
 - Large local growth > 4 cm.
 - Vaginal wall involvement (middle-lower 1\3)
 - Heavy parametrial infiltration
 - VVF or VRF
 - Inadequate space
 - Medical contraindications
 - Metastatic disease



Conclusions

Intracavitary Brachytherapy plays an important and predominant role in the cure of cancer of cervix.

Conventional low dose rate methods are being used with decreasing frequency.

MDR brachytherapy is being used in fewer and fewer centers now.

HDR brachytherapy is being used with increasing frequency and likely to replace conventional LDR and MDR brachytherapy completely in next few years.



Conclusions

However, it is necessary to have the knowledge of conventional low dose rate methods of intracavitary brachytherapy, because :-

1. Present day HDR & MDR brachytherapy is based on low dose rate conventional methods – applicator designed and dose prescription.
2. The doses prescribed are equivalent to LDR doses.
3. The clinical comparison of results are still done with conventional LDR brachytherapy.



Thank You

