General principles and applicator selection in gynecological brachytherapy

43rd ICRO PG TEACHING PROGRAM

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Pre- Brachytherapy patient evaluation

Go through the initial history and examination findings

-Gynaecologic examination findings at diagnosis (Clinical drawings at Diag. incl baseline imaging)
-Any co- morbities/ existing conditions (any surgeries, implants etc)

Pre -Brachy Gynaecological examination (Towards the end or completion of Ext RT/ at completion)

-Assessment of anatomy
-Residual tumor
-Acute toxicities
-Assessment for brachytherapy applicator best suited to the patient's anatomy and disease
-Anesthesia clearance
-Investigations (Hmg, Kidney func tests, Electrolytes, Bld sugars)

General Principles of Brachytherapy

Pre-Planning – No Surprises at the Table!

Deciding the appropriate brachytherapy technique

- Residual disease at brachytherapy
- Availability of applicator (type/no.)
- Availability of skill

Patient preparation

- Counselling and informed consent
- Fasting 6-8 hours
- Bowel preparation
- Perineal preparation

Brachytherapy Procedure

- EUA
- Bladder empty- foley's catheter
- Procedure under USG guidance
- Vaginal Packing
- Rectal tube (multiple fractions)

Post Brachy procedure

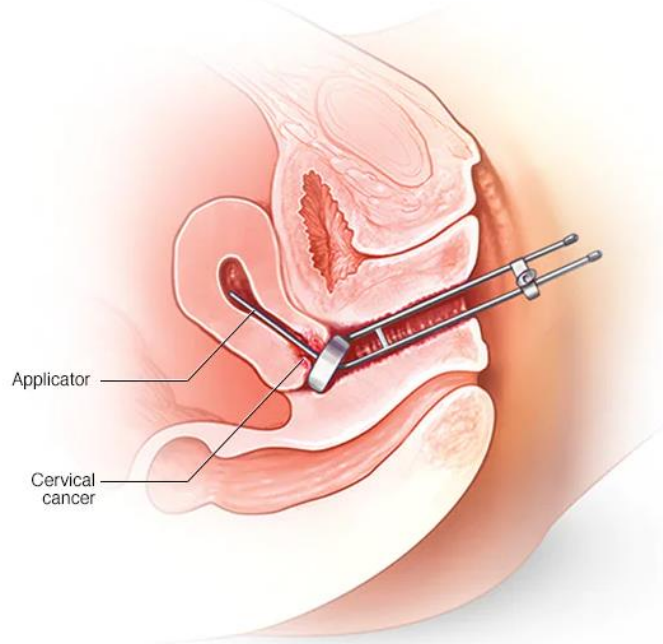
- Adequate analgesia
- Imaging – CT/ MRI
- Bladder protocol (Institutional)
- Contouring and Planning
- Applicator removal

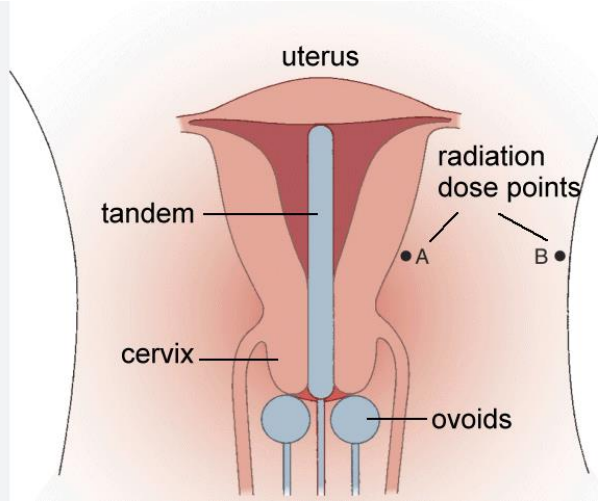
Intracavitary Brachytherapy

No residual disease, or residual disease at the cervix or limited to the medial parametrium and/or upper vagina

Applicator: Central tandem(Uterine canal)+ Ovoids/ ring (vaginal fornices)

Longest tandem- lateral throw-off of dose
Largest ovoid/ring- Decreased vaginal dose
Adequate vaginal packing- OAR displacement
Stabilize applicator



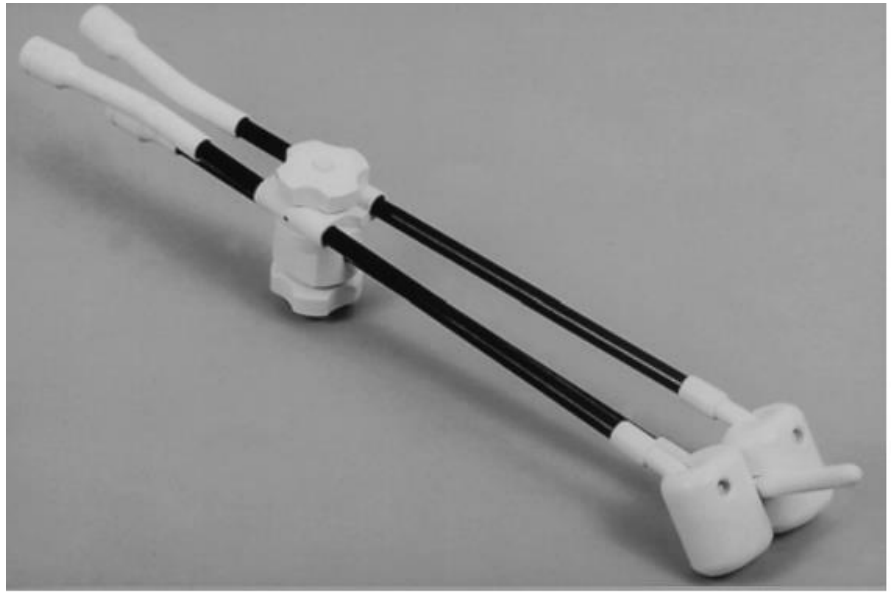


Intracavitary Brachytherapy applicators

Intracavitary brachytherapy (ICBT) applicators

Tandem and ovoid (TO) or Fletcher suit (FS) type applicator ICBT

Most commonly used applicators
Semi-fixed applicator (stainless steel or CT/MR compatible)
Designed to deliver adequate doses to uterus/cervix, upper vagina (2-2.5 cm) and medial parametrium by a standard pear-shaped dose distribution



Tandem and ring (TR) applicator – ICBT

Based on Stockholm System

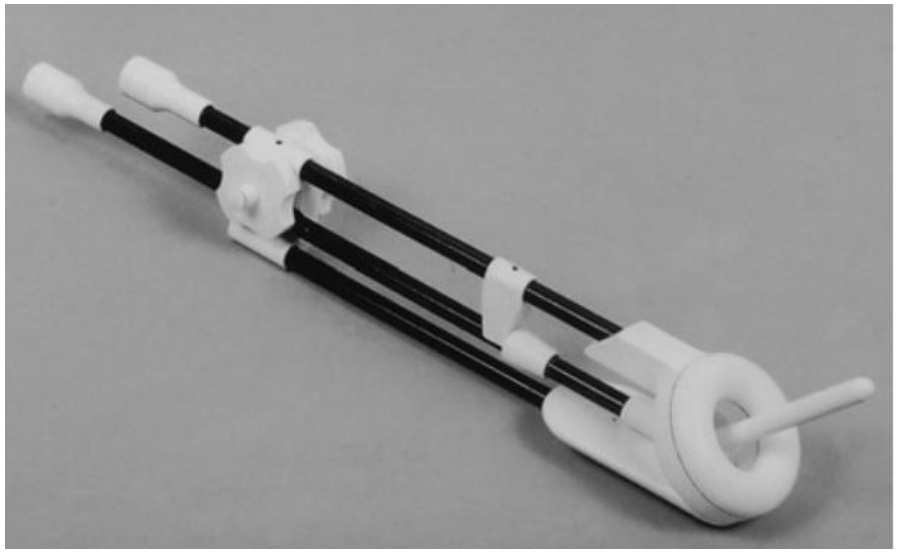
Advantages of easier placement and fixed reproducible geometry

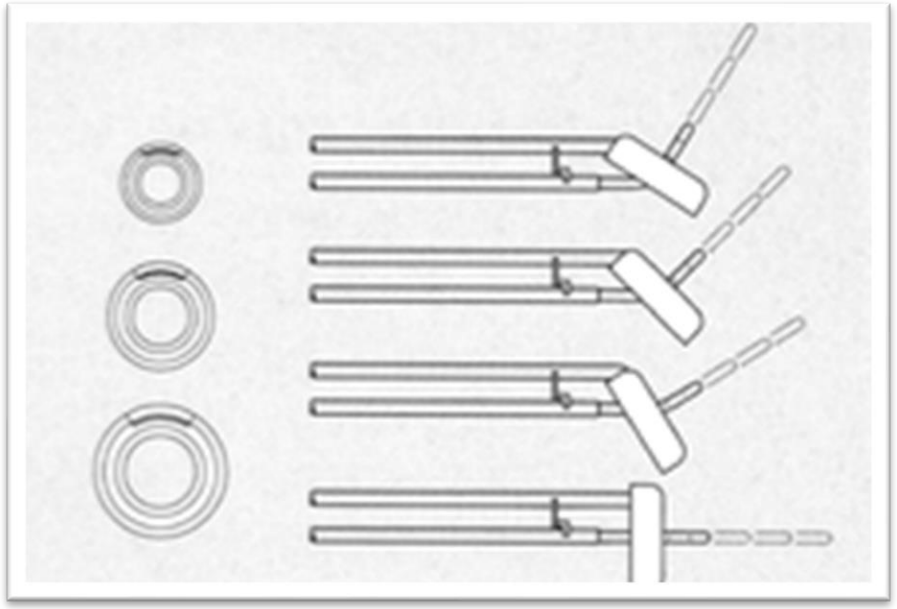
Additional freedom to load the vaginal sources in the ring

Increase dose to the vaginal surface

Sometimes not suitable for patients with a narrow vagina

Usually preferred in case of shallow fornices





TANDEM- CYLINDER APPLICATORS

- Consists of central tandem and vaginal cylinders
- Extensive vaginal disease to treat cervix and vagina in a single BRT application
- With narrow vaginal cavity
- The dose distribution -cylindrical.
- Lower absorbed dose in the lateral cervix and pelvic sidewall due to lack of ovoid and ring
- Single source channel, lateral throw-off of dose to parametrium is less
- Increased length of treated vagina in extensive disease.- High rectum and bladder toxicity
- Multichannel and shielded cylinder applicators- Possible to shape the dose distribution-Better protection of bladder and rectum

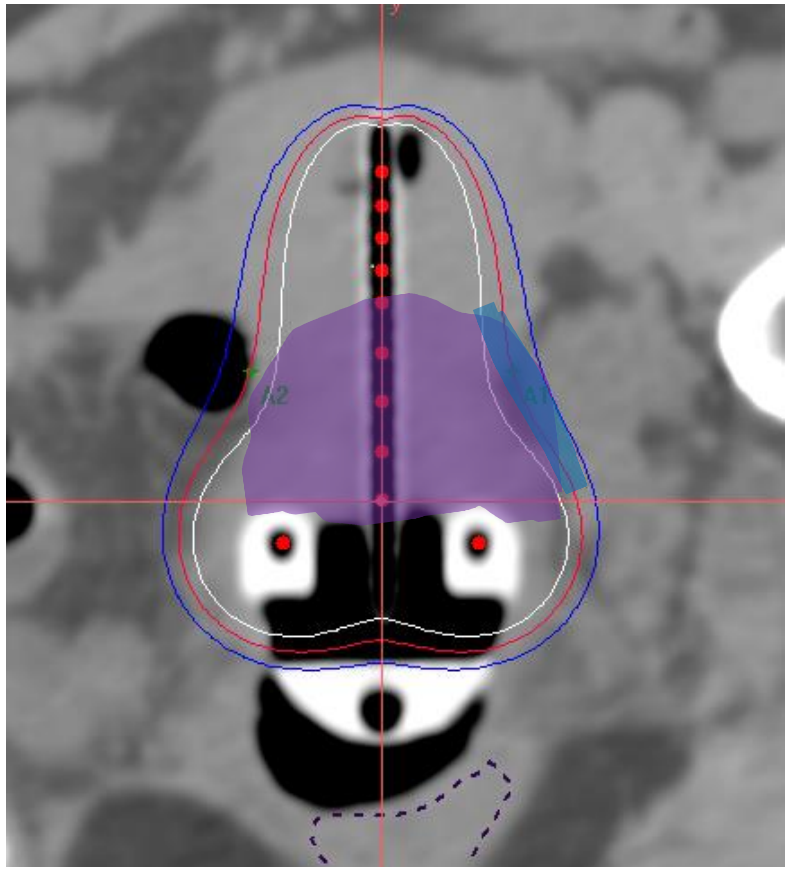
Combined Intracavitary- Interstitial Applicators

Disease extension into parametrium beyond the medial third at the time of BT, Large endocervical disease (not covered by ICA)

Principle:
IC+ IS application includes insertion of interstitial needles/tubes in addition to the standard ICBT procedure

The needles/tubes inserted through the array of holes in the ovoids/ring into the medial parametrium, in parallel direction to the tandem (e.g. Vienna applicator)

If the residual disease extends into the lateral parametrium, then insertion of additional oblique needles/tubes in the lateral parametrium can be attempted (eg Venezia, geneva applicator)



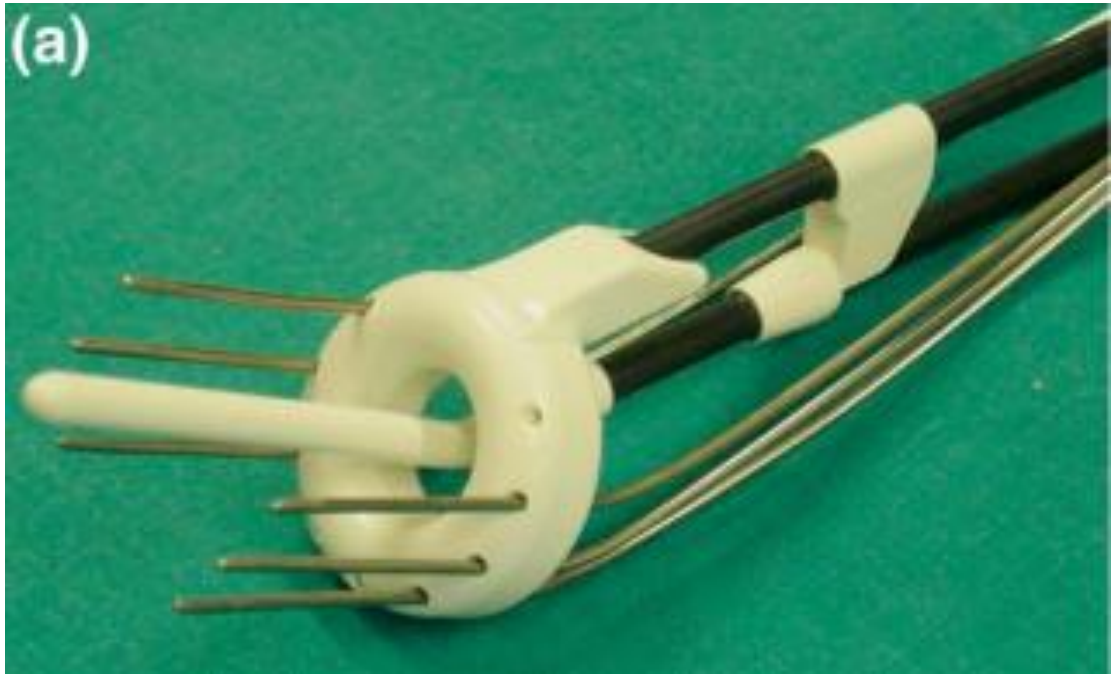
4-5cm length of needle inserted into the parametrium from the surface of the vaginal applicators (ovoid/ring)

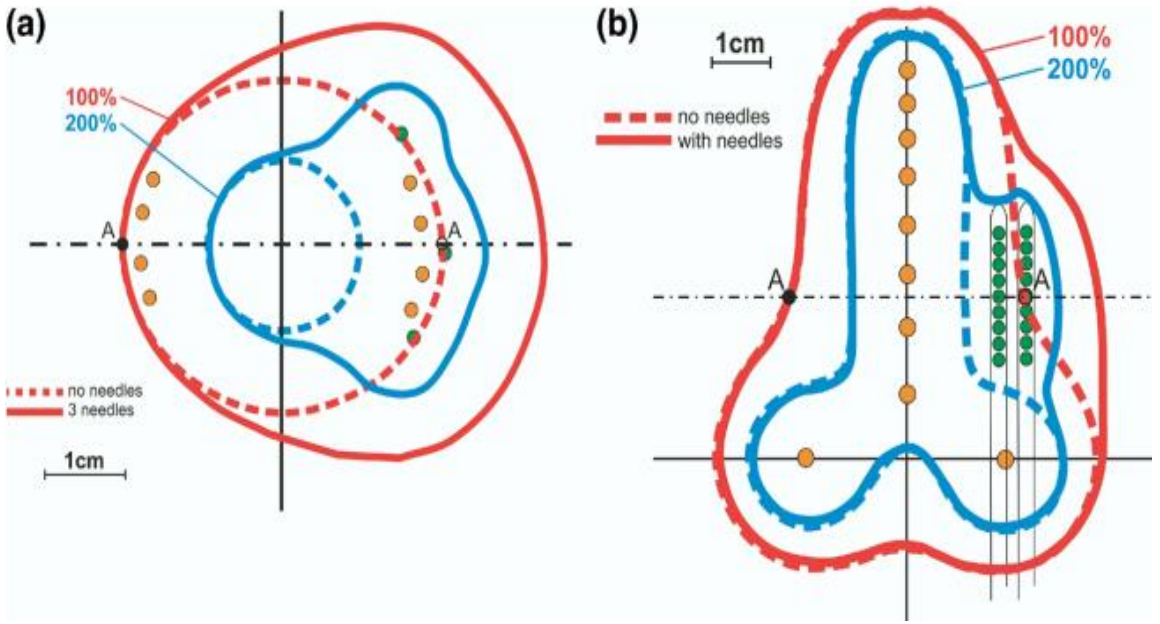
Traditional loading pattern for tandem and ring

Needles loaded starting at the tip and stopping at 1 cm from the vaginal source plane

Needle loading 10-20% of dwell weight the standard loading positions inside the T/R configuration- additional 1-1.5 cm lat coverage

Dose to point A not reported on side of needles implanted- extremely steep dose gradient





GENEVA APPLICATOR

Design inspired by Utrecht applicator
Advantages: Variability in applicator sizes

Hence, can be used in many different patient anatomies, where the option of interstitial is always available.

Suitable for treating majority of cervical cancer cases up to stage IIB

Advanced Intracavitary- interstitial applicator
VENEZIA APPLICATOR

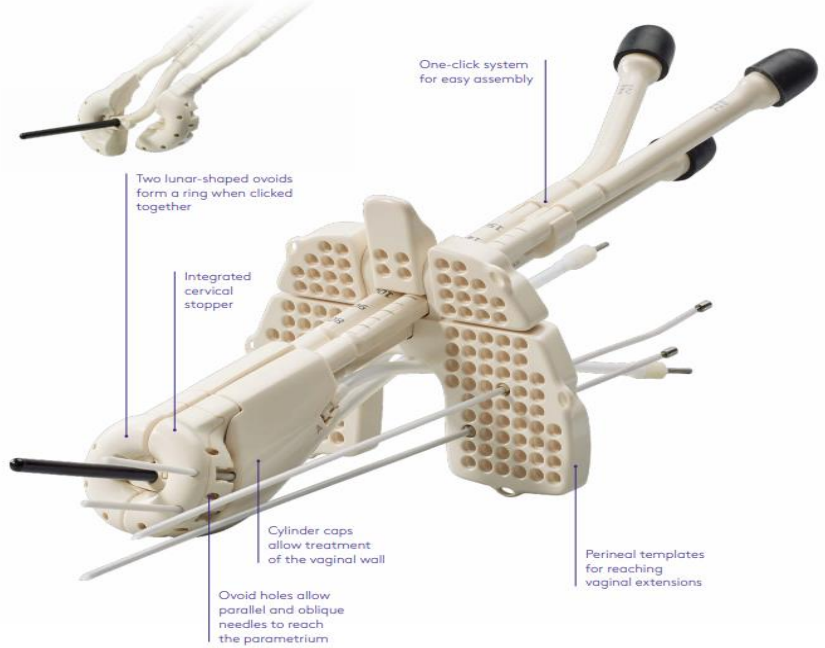
Consists of central tandem

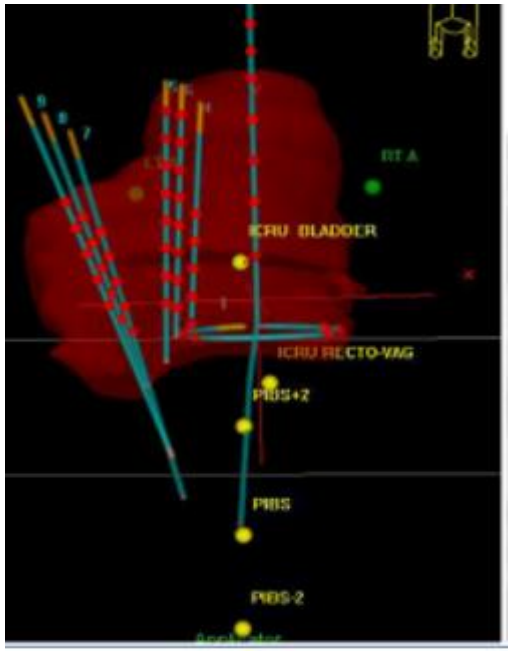
Ovoids/two ring halves that can accommodate **straight** or **diverging interstitial** parametrial needles

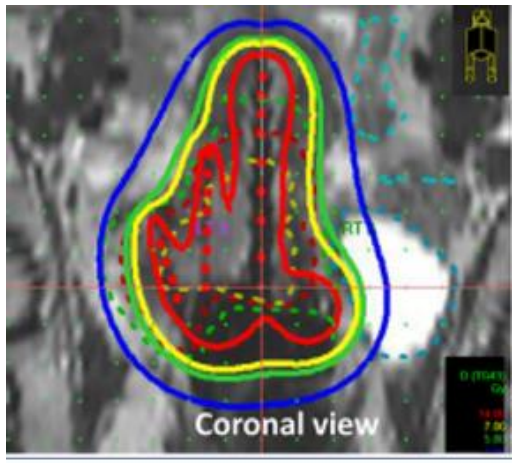
Detachable perineal template

Designed for treatment of involved **lateral parametrium** with the modified ovoid/ring 2 halves system and/or

lower vagina or paracolpos with the **perineal template**





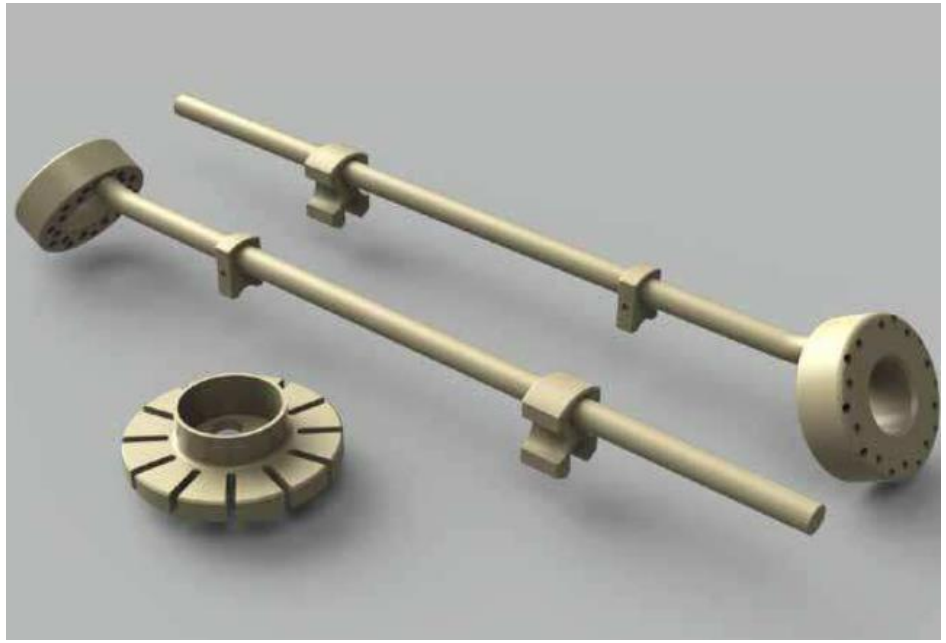


Mahantshetty et al, 2019

AARHUS APPLICATOR

Ring Applicator Set with needle template (32mm and 36 mm diameters)

Needles can be inserted in both parallel and oblique direction



Varian

Interstitial brachytherapy (ISBT)

Recommended in vault cancers with residual disease at vault with significant residual parametrial disease
Commonly used templates MUPIT and Syed-Neblett ,
Others- Benidorm template (MRI compatible), Pamplona applicator, Kelowna applicator, customized templates
Consists of a perineal template with provision of vaginal cylinder and tendem

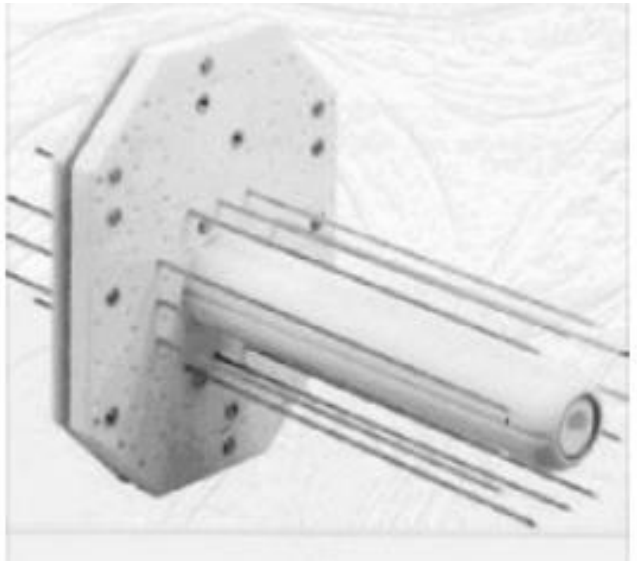
Principle of ISBT
Implantation of radio-opaque markers to mark the disease extent, as feasible.
Vaginal length determined using the central obturator
With the obturator in the vagina and the template against the perineum, needles with a trocar tip (18-20 cm length) are inserted through the perineum into the desired target adequately using an array of holes over the template.

MUPIT

Acrylic perineal template, central cylinder and tandem

Predrilled array of holes for passage of **straight and divergent needles**, and the cylindrical obturator.

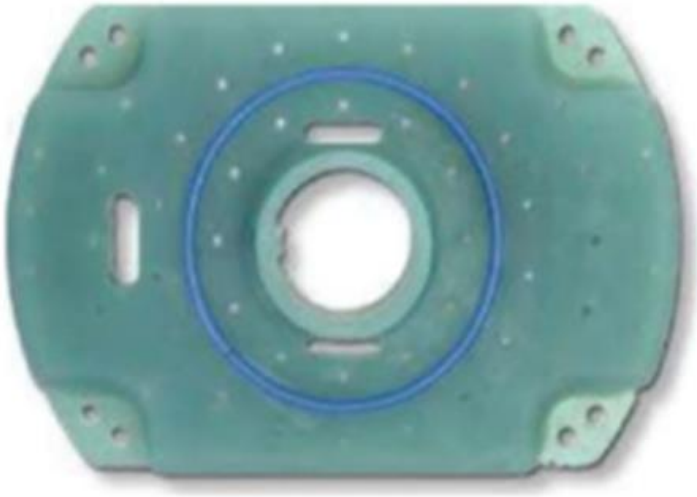
The needles can be secured for individual movements with the help of screws and a reinforcement plate



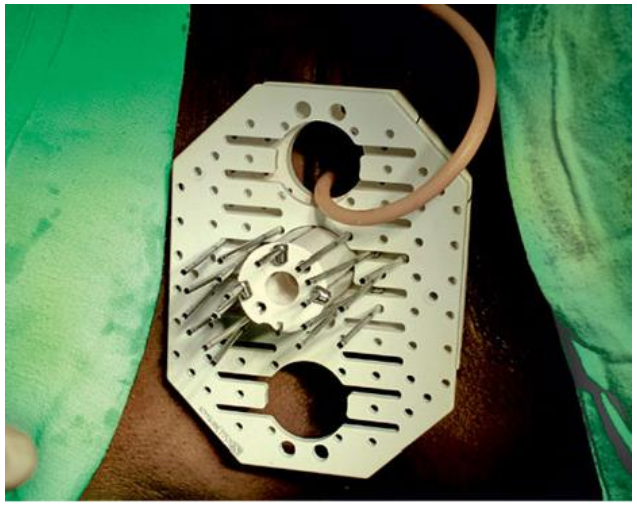
SYED NEBLETT

Perineal template

Central vaginal cylinder and tandem template provides an array of holes to insert needles/tubes through the perineum in a **butterfly shaped positions**



SYED NEBLETT TEMPLATE



MUPIT

Intracavitary Applicators

Ring applicator	Tandem Ovoid	Tandem Cylinder
Ring Applicator (Stockholm)	Manchester, Fletcher Henschke etc	Single channel Multi channel eg. Miami

Hybrid (Combined IC+ IS) applicators

Hybrid Ring	Tandem Ovoid	
• Vienna	Utrecht, Geneva	**Parallel Needles**

- Vienna II
- Aahrus applicator
- Venezia applicator

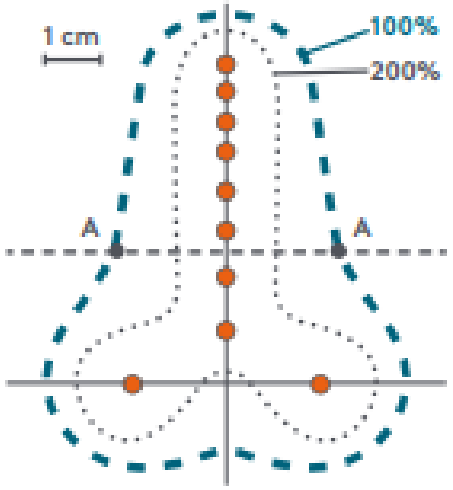
} **Parallel+ oblique needles**

- 3D Printed applicators: Tulip, AOLO, multichannel vag cylinder with IS needles etc

Interstitial applicators

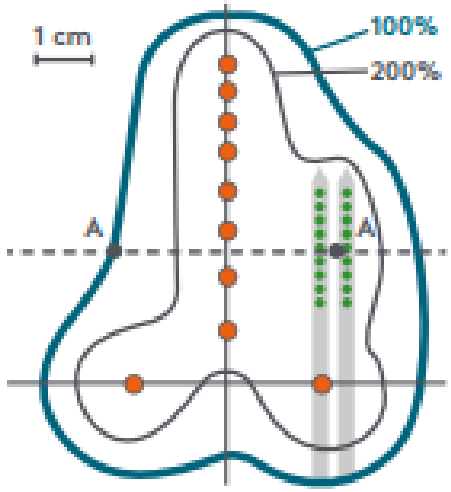
MUPIT, Syed Neblett, Indigenous templates with needles, tubes etc

DOSE DISTRIBUTION WITH PARALLEL & OBLIQUE NEEDLES

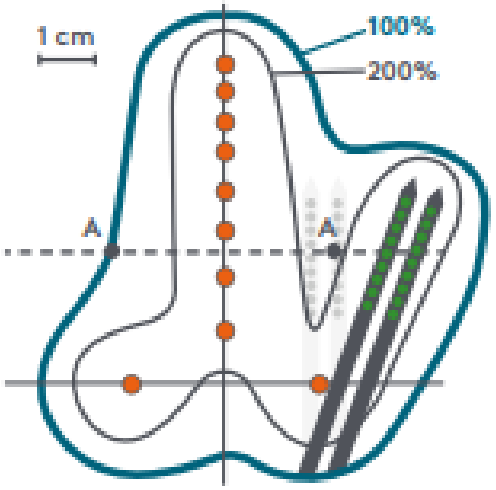


Intracavitary brachytherapy

Adapted from Kirisits C et al.[14]



With parallel needles



With parallel and oblique needles

(The parallel needles are not on the same plane.)

	IC only	IC+ parallel needles	IC+ Parallel+ Oblique needles
Physical distance between tandem and needle	No needle	20mm	23-27mm
Needle loading in relation to IC	0%	10-20%	5-10%
Distance: tandem to prescribed isodose at level of Point A	20 mm (15-25mm)	25-35 mm	35-40mm

CONCLUSION

The patient's anatomy and extension or location of the disease plays a crucial role in the selection of a suitable brachytherapy applicator to treat cervical cancer.

The choice of brachytherapy technique depends upon residual disease at brachytherapy

- **Confined to cervix - Intracavitary Brachytherapy**
- **Disease beyond cervix- Intracavitary + interstitial Brachytherapy**
- **Extensive disease - Interstitial Brachytherapy**

Post op recurrence/residual