



Brachytherapy with Perineal Templates

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HISTORY OF PERINEAL BRACHYTHERAPY

- **1909** : Pasteau & Degrais → Transurethral Radium Capsules : Ca Prostate.
- **1951** : Interstitial injections of colloidal solution of radioactive Au-198 : Prostate
 - Subsequently I-125 and Pd-103 were also evaluated.
- **1920s**: Interstitial Gynaec.
 - Transvaginal insertion of long low intensity radium needles into the cervical, vaginal and parametrial tumour volume
 - Perineal brachytherapy by Waterman

Not popular for a long time

- **1978** : Feder, Syed and Neblett rediscovered the technique using plastic templates and LDR Iridium wires
- **1980s** : Syed and Neblett propagated use of the template in Anorectal and Prostate cancer
- **1982** : Martinez published the construct and dosimetric characteristics of MUPIT (Martinez Universal Perineal Interstitial Template). Since then many modifications of designs of these have been described



Perineal Interstitial Brachytherapy

Gynec.

Cervix

Endometrium

Vagina

Vulva

G.I.

Ca Anal Canal

Urological

Prostate

Distal
Female
Urethra



GENERAL PRINCIPLES OF PERINEAL INTERSTITIAL IMPLANTS

- Evolution from Manchester system with Radium to Paris System for present generation Afterloading techniques.

The following principles are followed

- Radioactive lines must be rectilinear, parallel with centers in the same plane (**central plane**), perpendicular to the direction of the lines.
- Equidistant adjacent radioactive lines
- Separation between planes is 0.7 distance between two needles in triangular geometry and equal to the distance of needles in a square geometry.
- Reference linear kerma rate or the linear activity along each radioactive line must be uniform and identical for all lines.



Dosimetry

- Target is taken as the volume defined by the peripheral needles.
- Minimum target dose rates → between 0.5 and 0.7 Gy/h.
- Source strengths depend on
 - size of the implant (number of needles and treatment length)
 - shape of the implant volume
 - Spacing between sources.
- Maximum significant dose (MSD) :
 - Highest isodose curve that encompasses three or more contiguous needles.
 - ABS : MSD not > 125% of the prescribed dose.
 - Can be used to evaluate dose homogeneity.
- Spacing between source centers may be 0.5 or 1.0 cm.
- In general, with 1-cm needle spacing, the source strength for interior needles should be about twice that of the peripheral needles.

ABS IJROBP 2002

Stepping Source Dosimetry System (SSDS)

Extension of the Paris system wherein dose at periphery is increased by increasing dwell times rather than the length of the implanted needles.

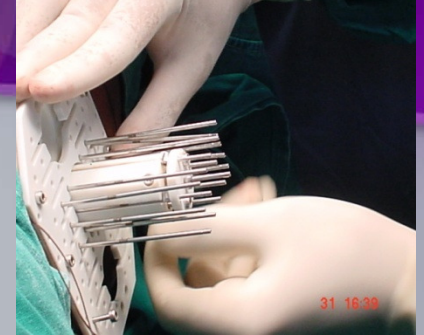
Optimization Techniques

- Dose point optimization:
- Geometric optimization

Often the best results are obtained in volume implants by a combination of dose point & geometric optimization



INDICATIONS FOR interstitial BRACHYTHERAPY in Ca Cervix



1. Ca Cervix IB, II B & above if

1. distorted anatomy
2. narrow vagina and obliterated fornices
3. Os / Uterine canal not identifiable

Good geometry
with ICA
difficult

2. Extensive paravaginal (>0.5cm) or distal vaginal involvement
3. Bulky parametrial disease which will require boost.
4. Persistent or Recurrent Ca Cx post EBRT +/- ICA.
5. Carcinoma of the cervical stump, Cut through hysterectomy.
6. Post operative vault recurrence



INDICATIONS FOR PERINEAL BRACHYTHERAPY

Ca Endometrium

Local recurrence Post Sx +/- RT extending beyond the confines of vaginal vault (not extending to the pelvic wall)

Vagina and Vulva

- 1. Radical Brachytherapy in early lesions (T1/N0)**
- 2. Boost in addition to external beam radiotherapy in large lesions (T2/3).**
- 3. Locally confined recurrent cases.**



INDICATIONS FOR PERINEAL BRACHYTHERAPY

Urethra

Interstitial Brachytherapy alone for superficial lesions in distal female urethra.

Gastrointestinal

- 1. Boost after external beam radiotherapy in anal canal carcinomas.**
- 2. Recurrent anal canal carcinomas**



CONTRAINDICATIONS FOR INTERSTITIAL PERINEAL BRACHYTHERAPY

General Contraindications:

1. Risks for GA/ Epidural anesthesia due to medical reasons.
2. Distant metastases.

“Careful selection of cases”

Specific Contraindications:

1. Residual disease upto lateral pelvic wall.
2. Disease infiltrating rectovaginal septum /posterior bladder wall at the time of brachytherapy.
3. Large volume residual lesions.



Gynecological

- **Syed Neblett Applicator.**
- **MUPIT.**
- **Vienna Applicator.**
- **Hammersmith Hedge Hog.**
- **Queen Mary Hospital Applicator.**

APPLICATORS

Gastrointestinal

- **Syed Neblett Rectal Applicator**
- **MUPIT**

Genitourinary

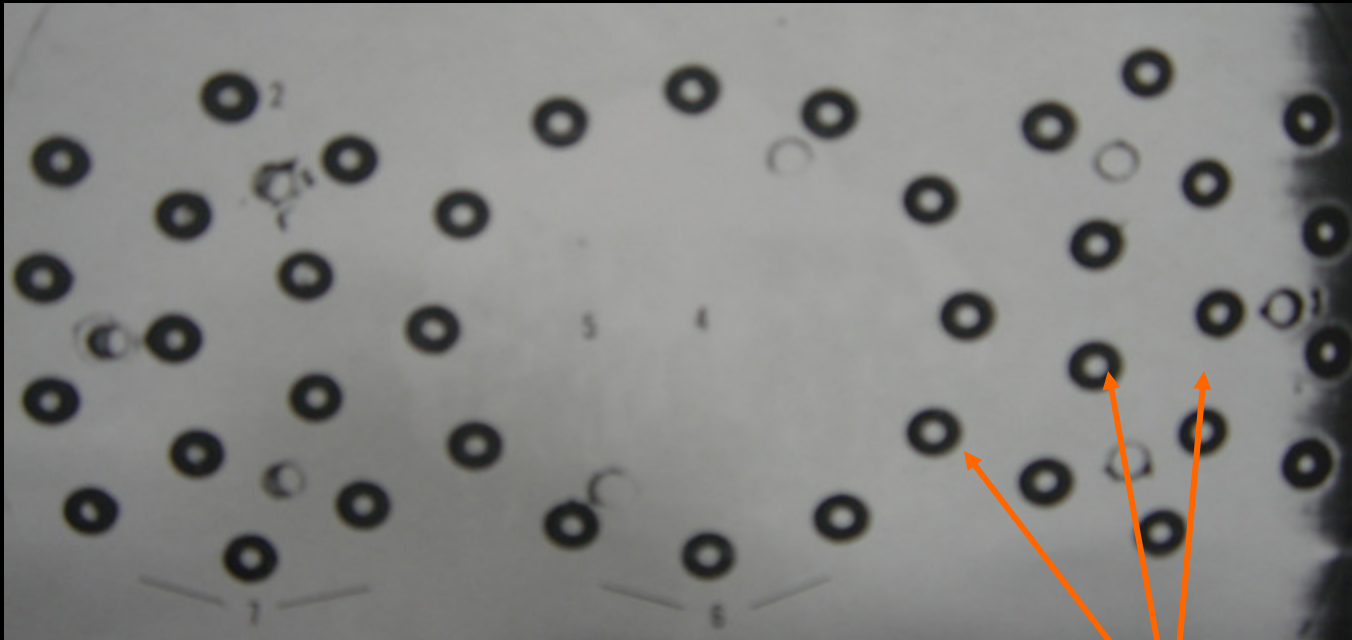
- **Syed Neblett Prostate Applicator**
- **MUPIT**
- **Mick's Applicator for Prostate Seed Brachytherapy.**
- **Mount Vernon Applicator.**



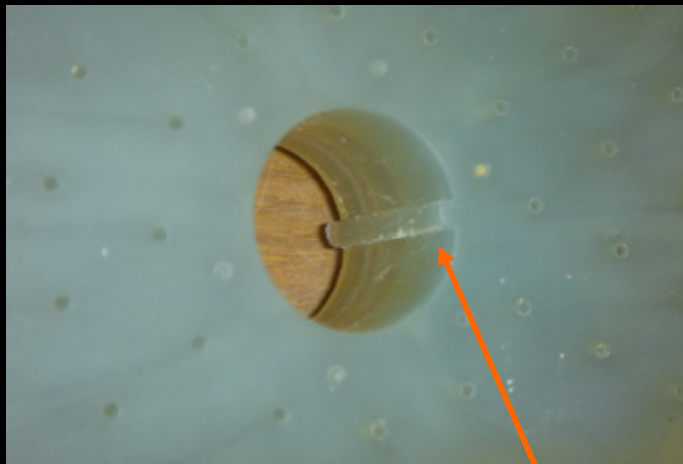
SYED-NEBLETT TEMPLATE

- Two Plastic / Silicone plates 1.2 cm thick
- 2 cm central hole for vaginal obturator,
- 34 holes with rubber rings (O-rings) drilled 1 cm apart in incomplete **concentric circles** to accommodate the guide needles.
- Vaginal obturator
 - ✓ 2 cm diameter
 - ✓ Three different lengths of 12, 15 and 18 cm
 - ✓ Central tunnel to accommodate tandem
 - ✓ Six longitudinal grooves on the surface for guide needles
 - ✓ Embedded screw at it's distal end to secure the tandem.
- 17 Gauge hollow needles 20 cm long.
- Long axis held perpendicular to sagittal plane to treat parametria.

Feder, Syed, Neblett IJROBP 1978



**Concentric
arrangements**



**Ridge for
obturator**



Obturator with grooves



**Prostate
&
Anal Canal**



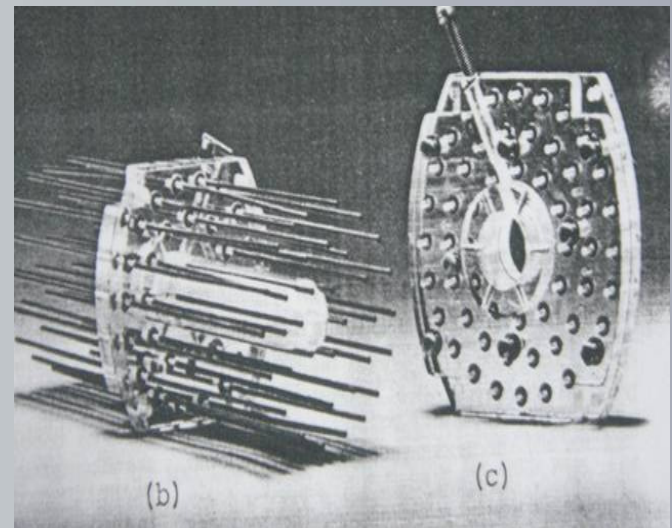
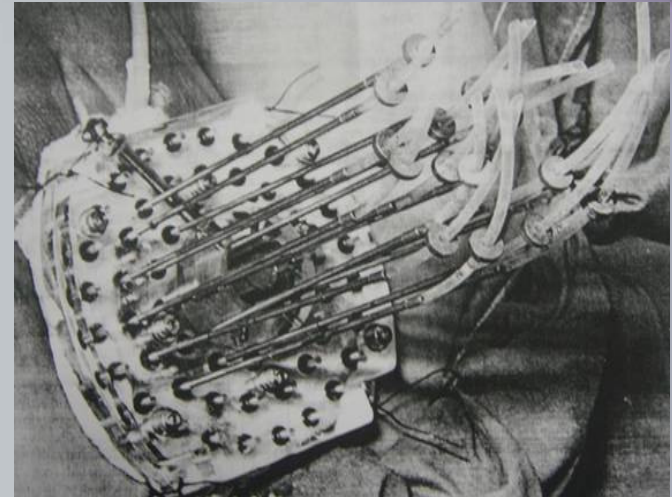
Orientation of Central Rings



HAMMERSMITH PERINEAL HEDGEHOG

- **Modified Syed-Neblett template.**
- **Held with long axis parallel to sagittal plane.**
- **Three or four complete concentric rings of holes produced as compared to laterally deficient Syed-Neblett (for treatment of lower vagina and vulval cases)**
- **Outer tubings with lead washers at needle ends, with decreasing length P→A**
- **Allows ease while loading and helps fix Ir. Wires.**
- **Cs-137 source can be inserted through the central needle to substitute for the central ring of needles.**

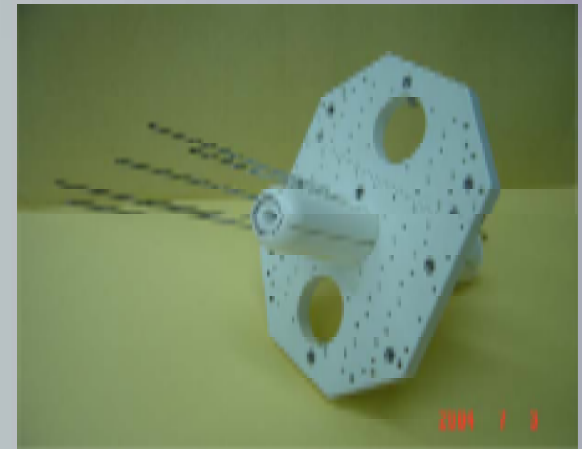
Br J R 1985, Branson et al





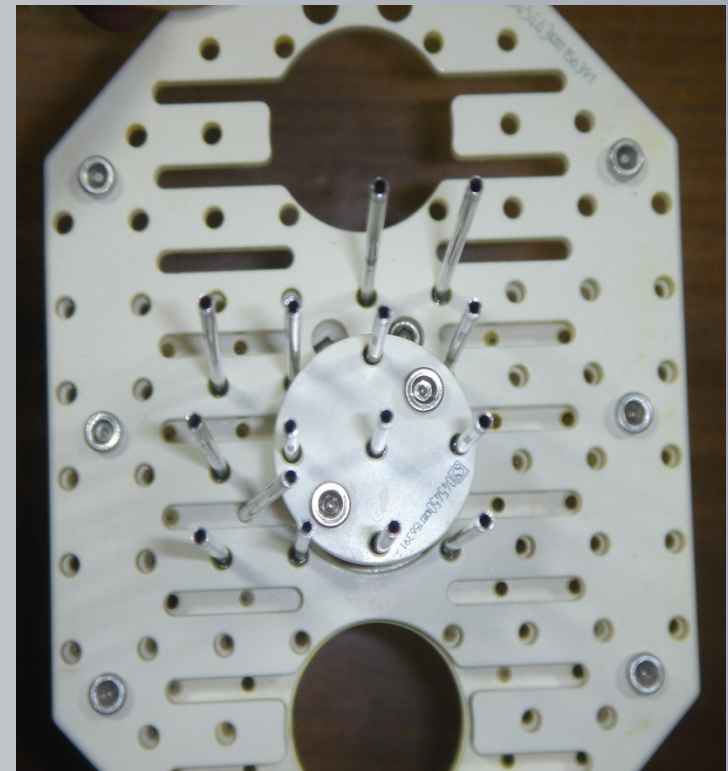
MUPIT (Martinez Universal Perineal Interstitial Template)

- **Multiple site single template**
- **Used for cervical, vaginal, female urethral, perineal, prostatic and anorectal carcinomas.**
- **Consists of**
 - ✓ **Flat acrylic template and flat acrylic cover plate. (11x8x1cm)**
 - ✓ **Acrylic obturator (two sets), screws and stainless steel needles**
 - ✓ **Three large holes are located along the vertical centerline. The top slot hole is for the passage of Foley catheter from the urethra and central and bottom holes for the vaginal and rectal cylinders.**
 - ✓ **Array of holes that for the most part determine the geometry of source placement with respect to anatomic structures.**





- **Type I holes**
 - Perpendicular to the template,
 - Only volumes extending 4 cm to either side can be covered
- **Type II holes**
 - Oblique to the template, angled approximately 13 degree laterally outward.
 - Divergent rows allows coverage of larger volume of parametrium without hitting the ischium.
 - Type II holes volumes extending outward to 7 cm can be covered upto a depth of 14 cm.
- **Central hole in vaginal cylinder**
 - space for uterine tandem or
 - hole for drainage of secretions.
- Each **cylinder** → 8 guide holes for placement of trocars near the vaginal or rectal wall.





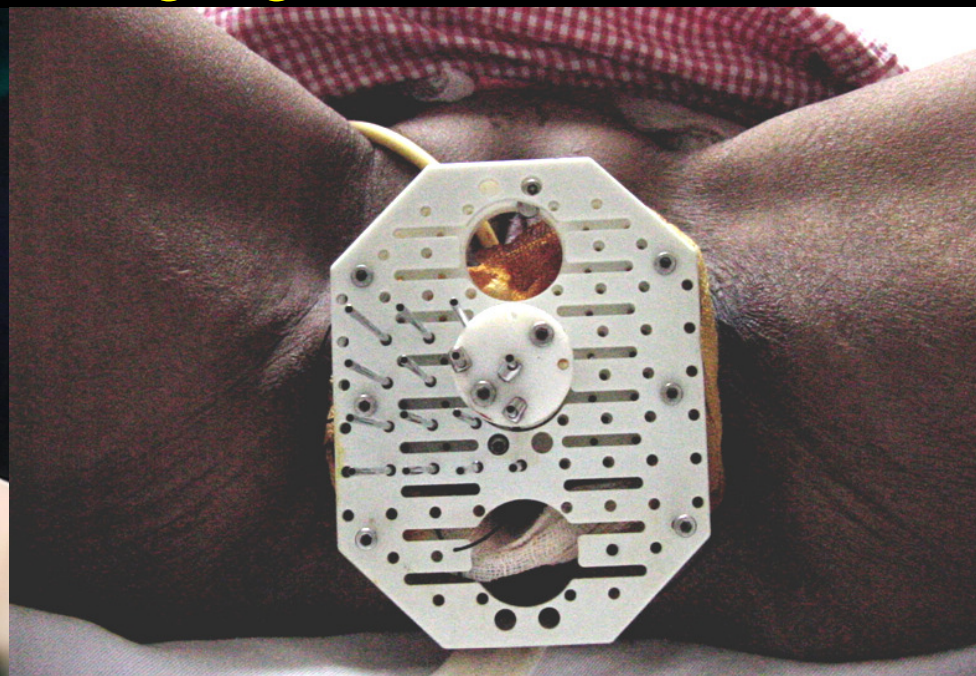
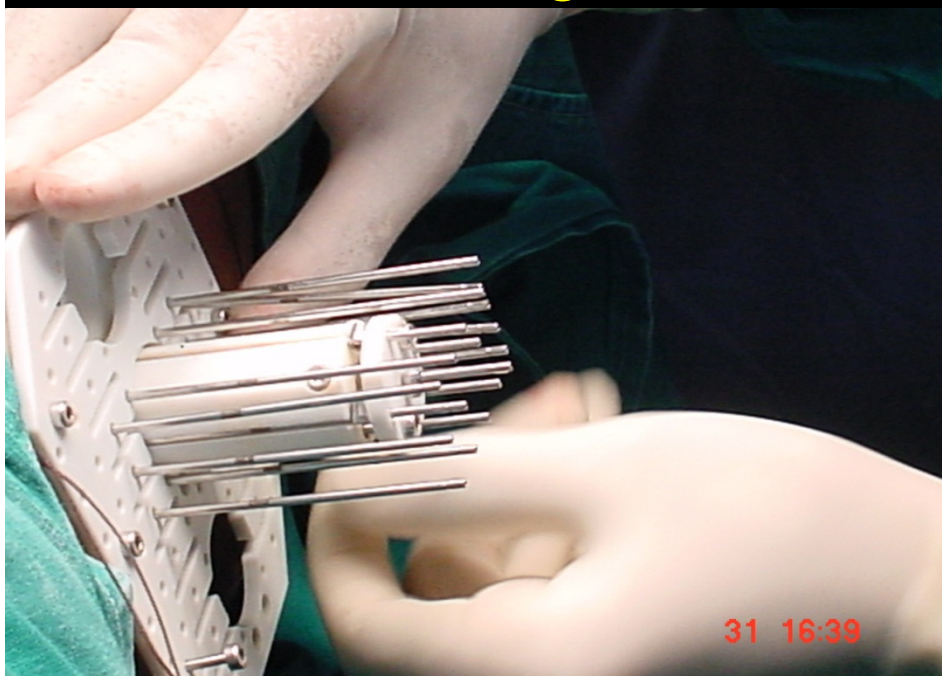
Perineal Interstitial HDR Brachytherapy

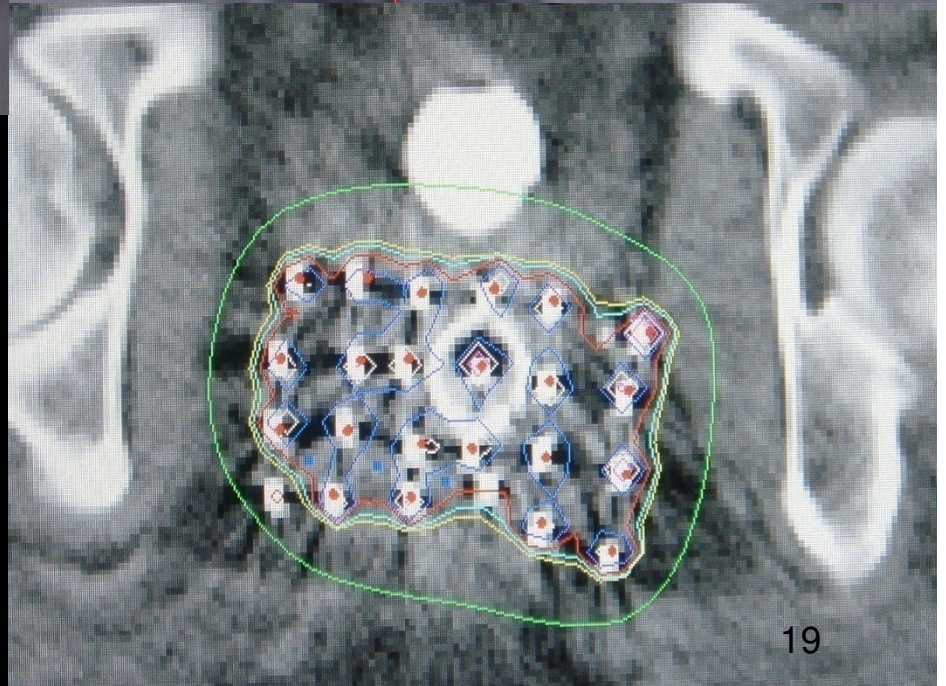
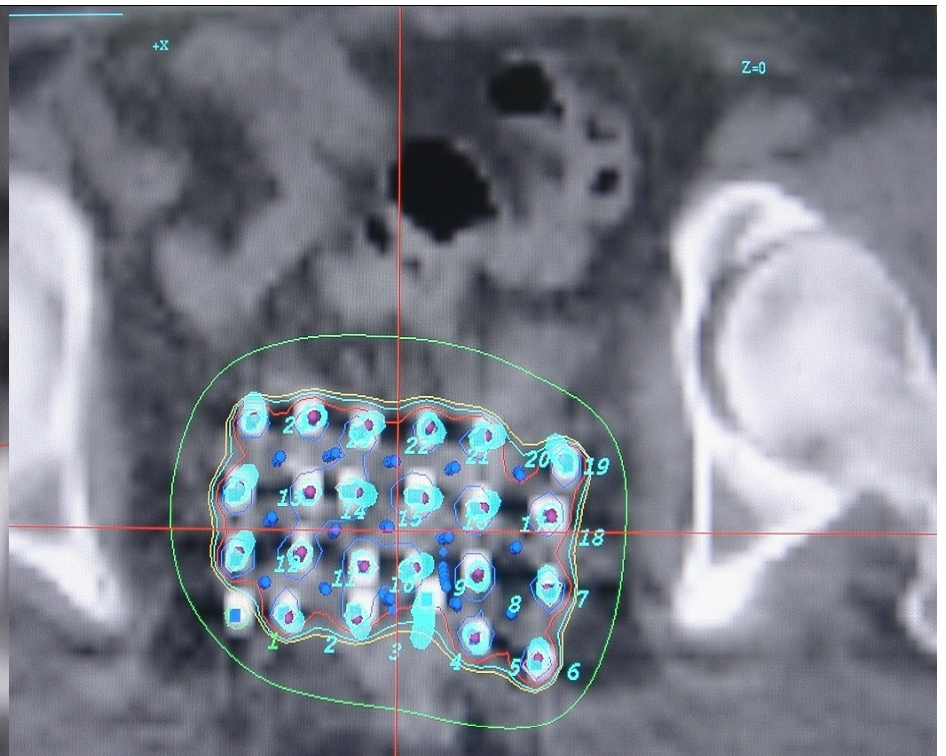
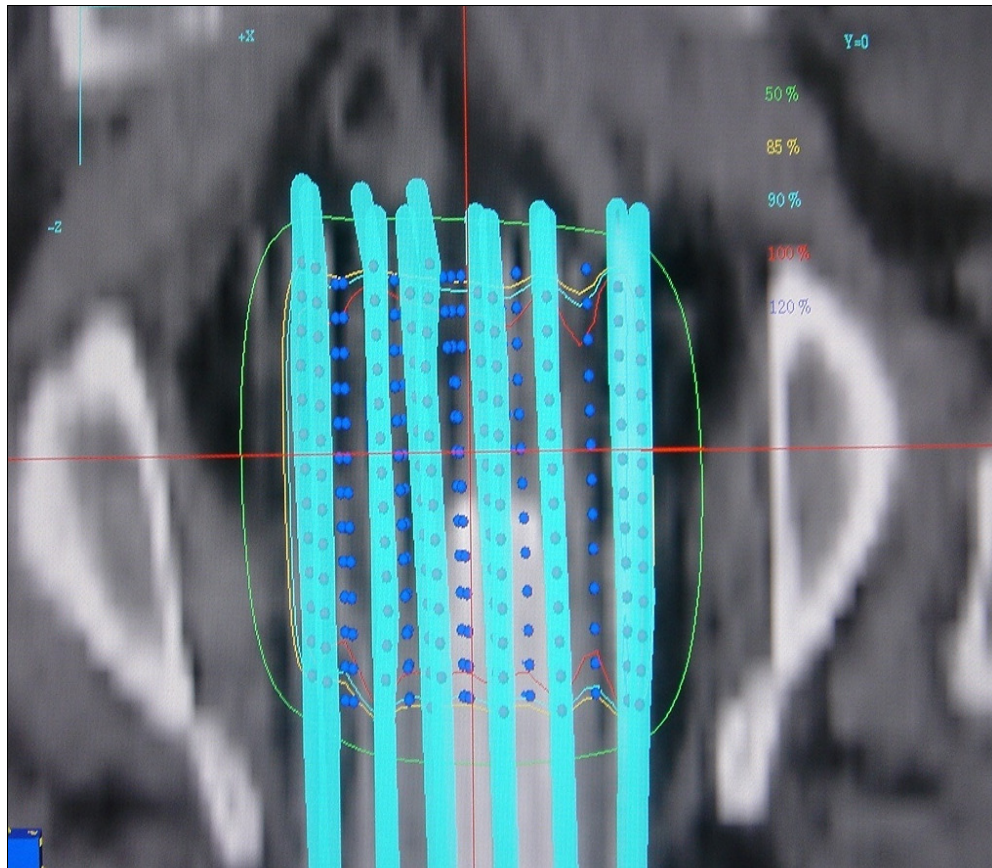
Martinez Universal Perineal *Interstitial Template* MUPIT

- 25 Needles, Multiple plane implant
- CT Scan images with 3-5 mm slice thickness
- Image acquisition and Delineation
- Catheter reconstruction and
- Source loading (6-6.5 cm)
- Basal dose points (Paris Dosimetry system)
- Dose prescription
- Geometrical Optimization based on volume
- Graphical Optimization
- Plan evaluation (DVH)



MUPIT IMPLANT IN CA CERVIX



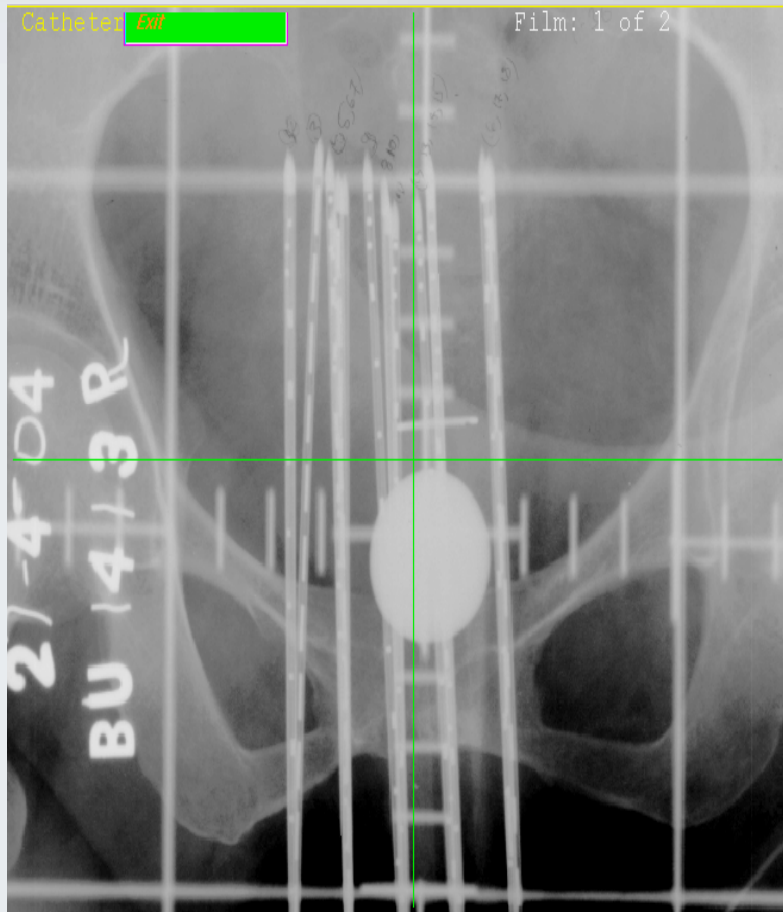


PERINEAL INTERSTITIAL BRACHYTHERAPY

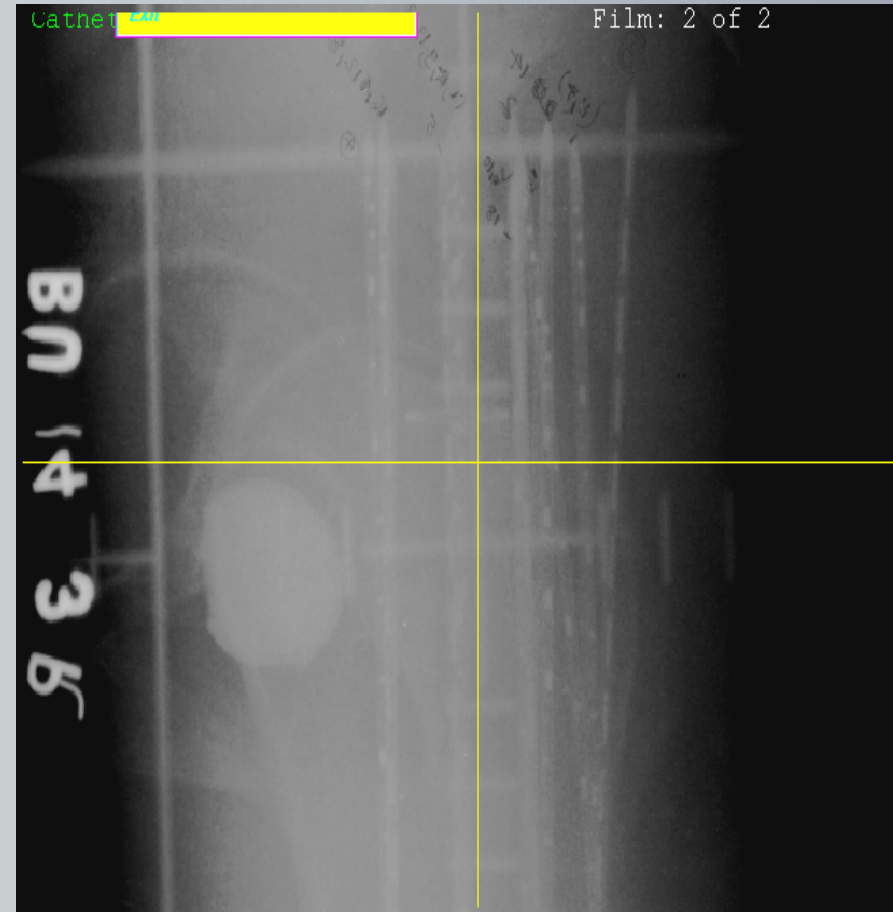


Image Acquisition for MUPIT Template

Ant Radiograph



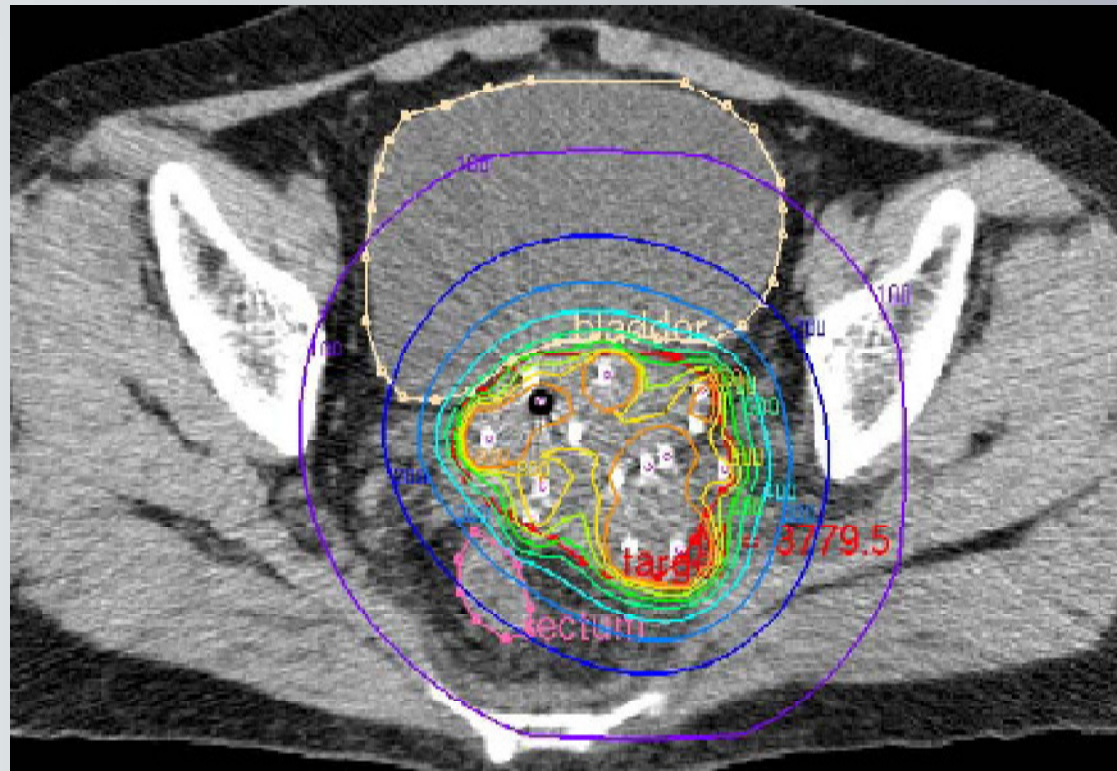
Lat Radiograph



Implant Orientation and Needle identification is very important

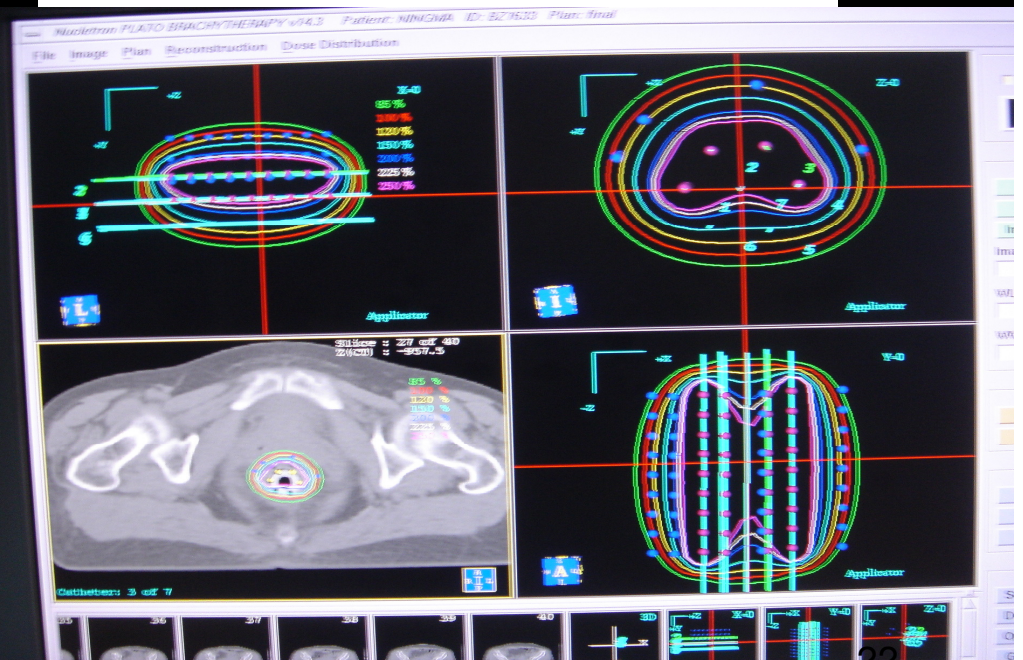
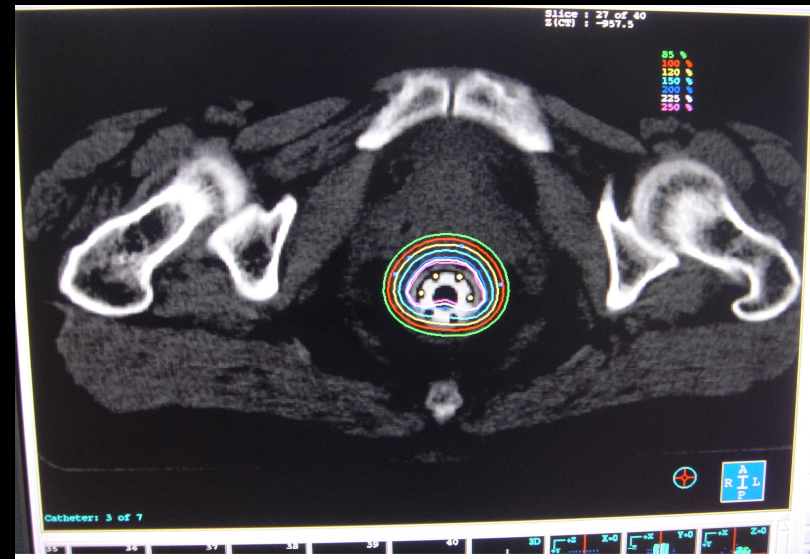
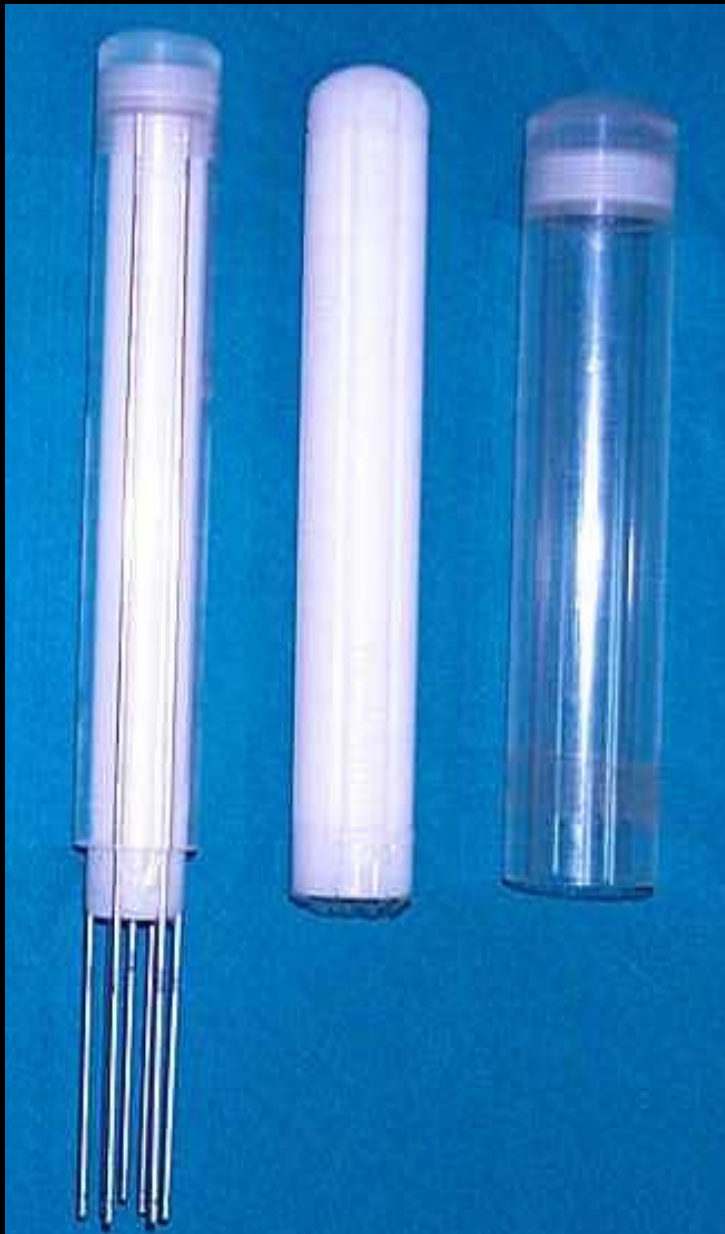


Bachytherapy



Good implant procedure = good dose distribution
— Image-guided approach is important —

PERINEAL TEMPLATE-TMH



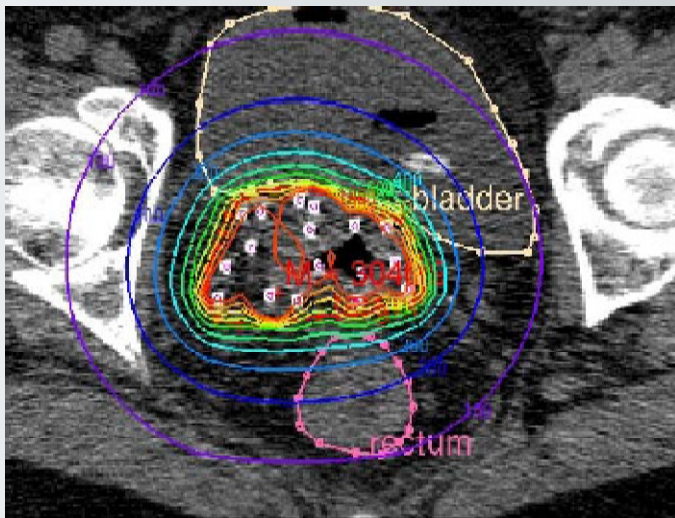
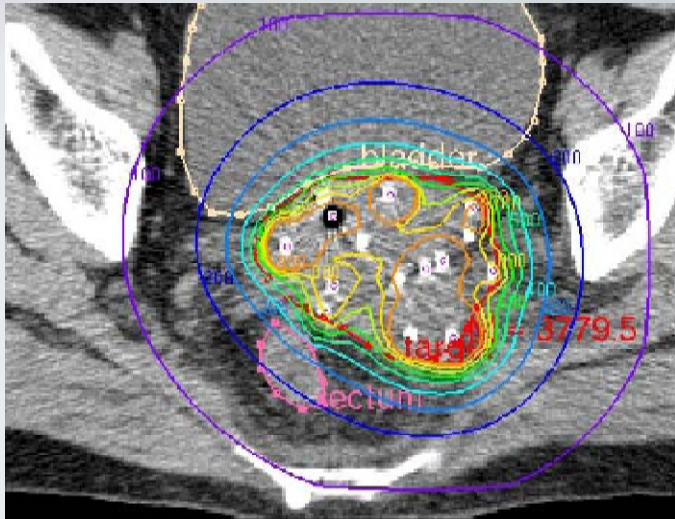


Recent advances of brachytherapy

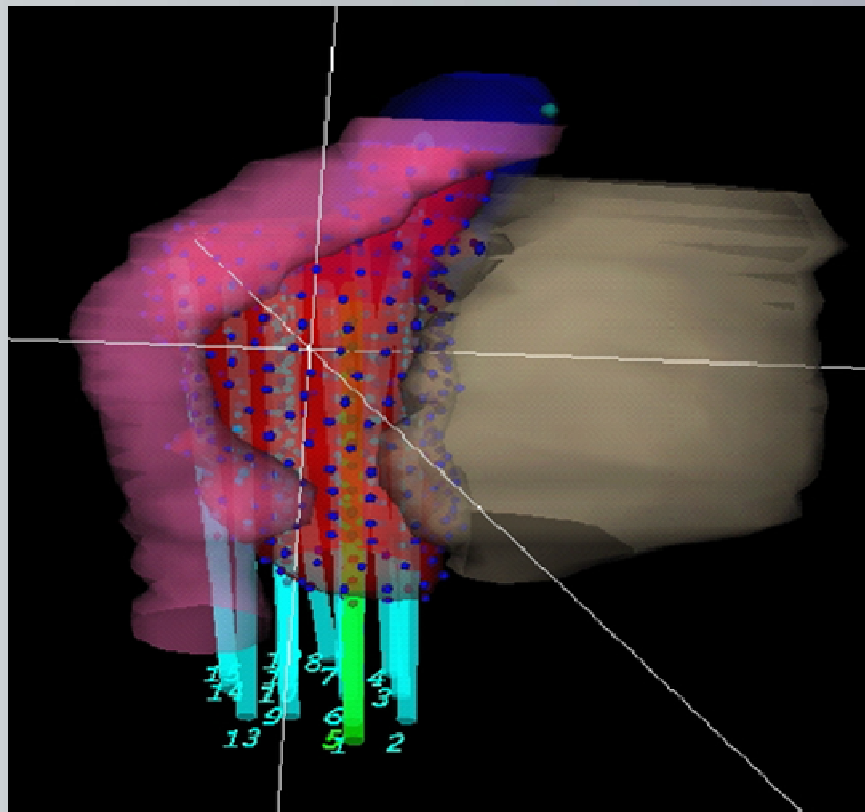
- 1: image-guided
- 2: Image-based
- 3: high dose-rate (optimization)
- 4: interstitial approach



Image (CT) based brachytherapy planning

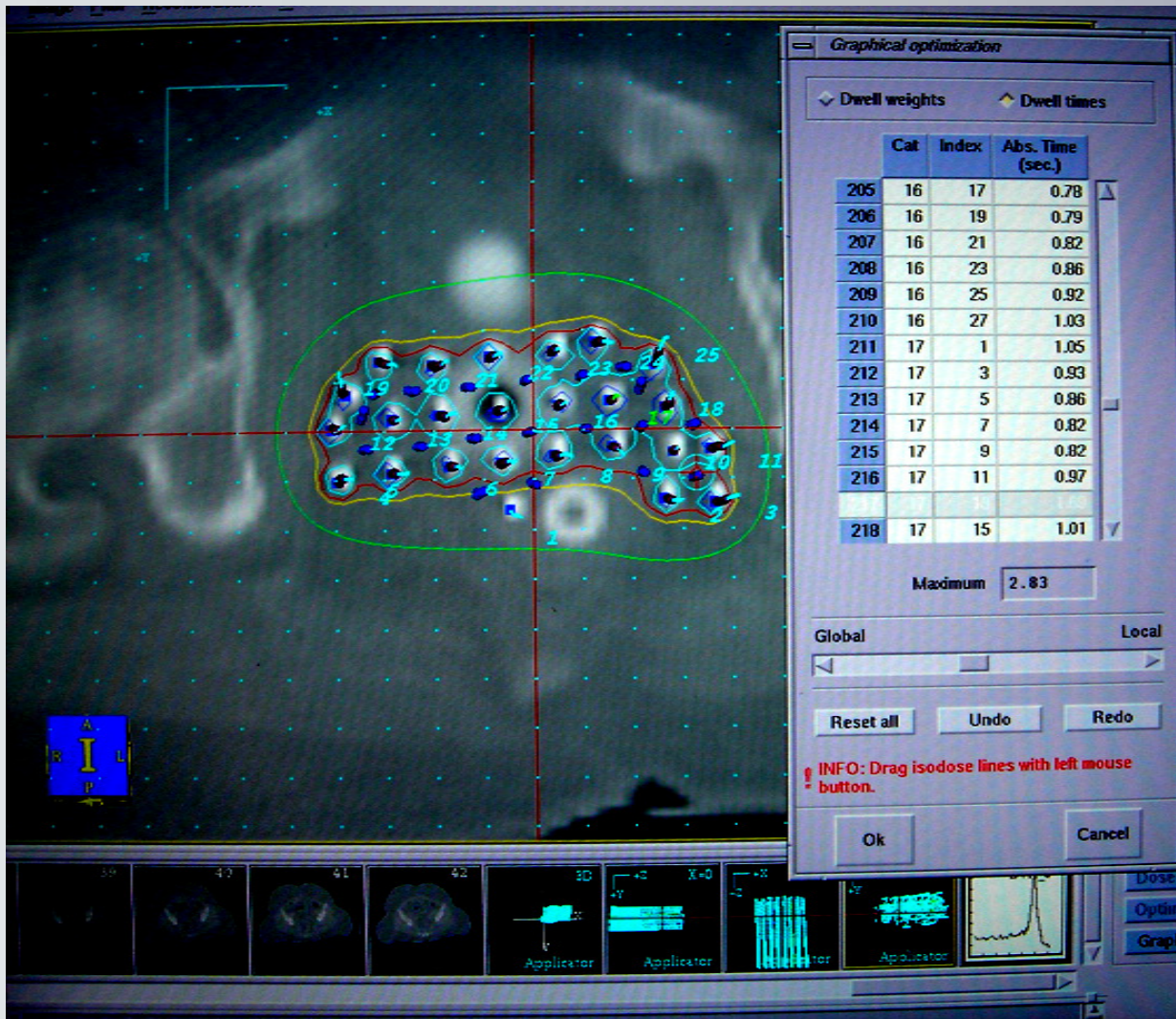


- visible target and OAR
- easy reconstruction of the needles
- optimization program



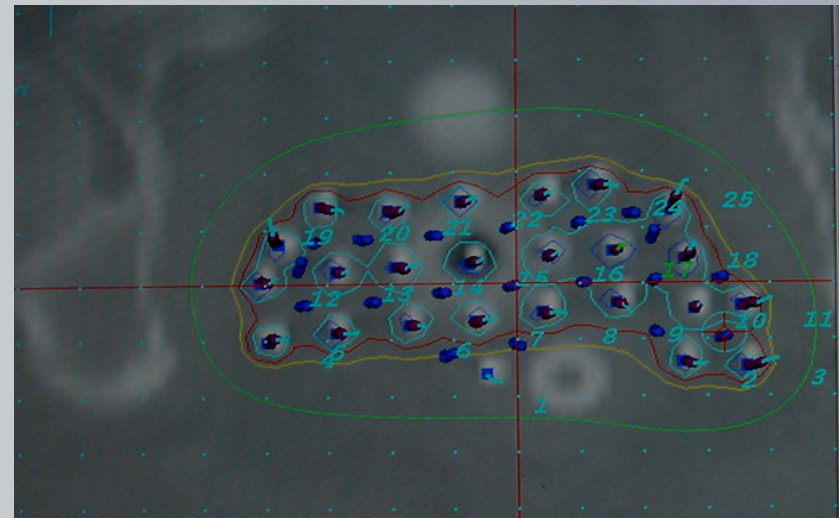
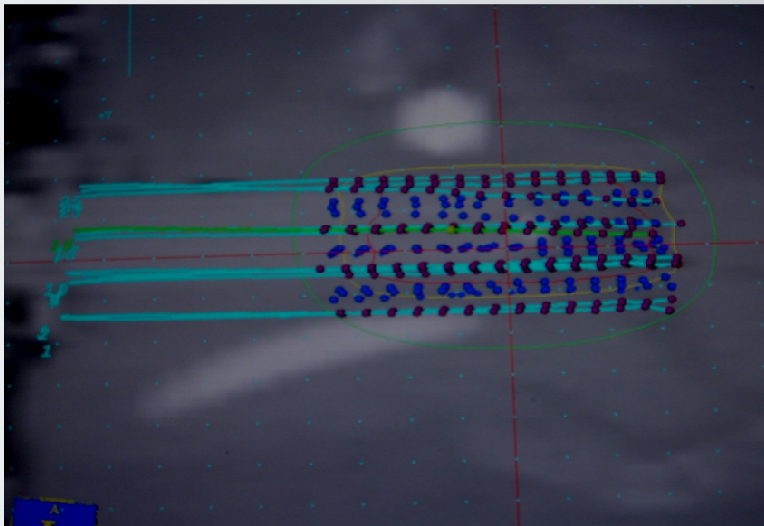
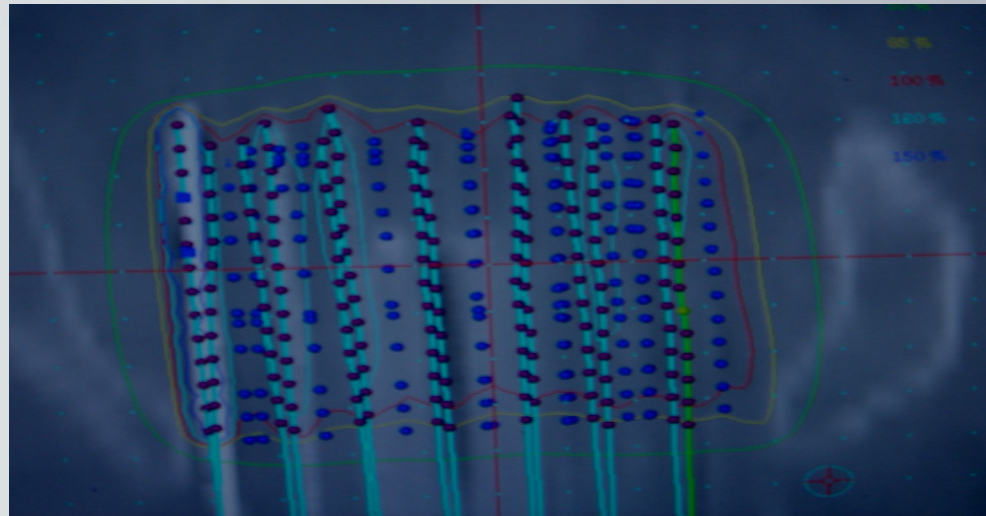


Graphical Optimization Technique



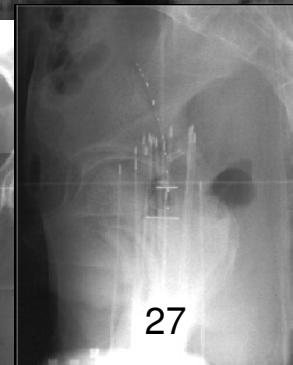
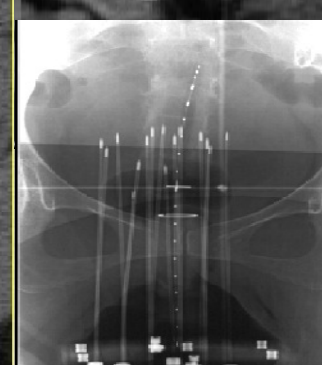
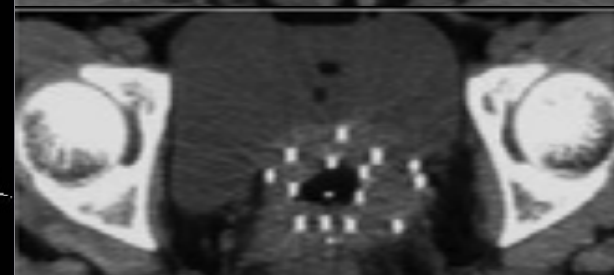
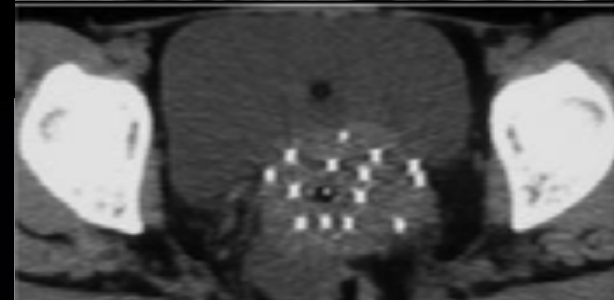
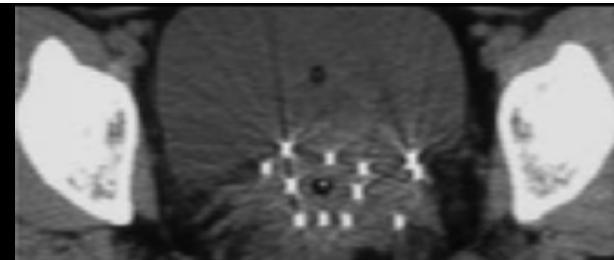
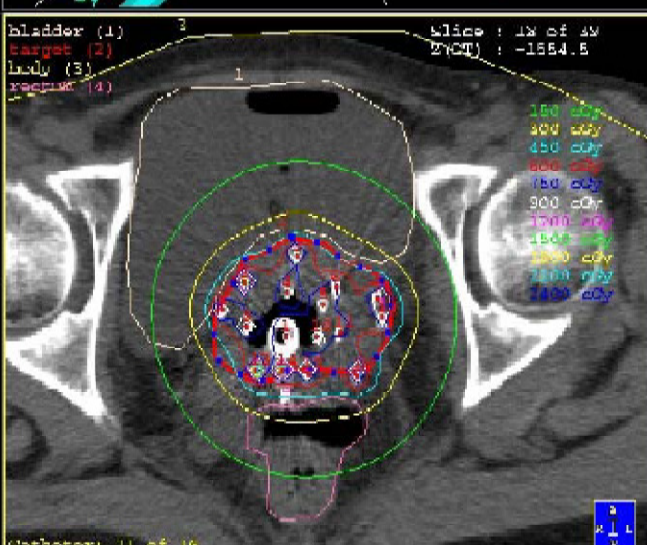
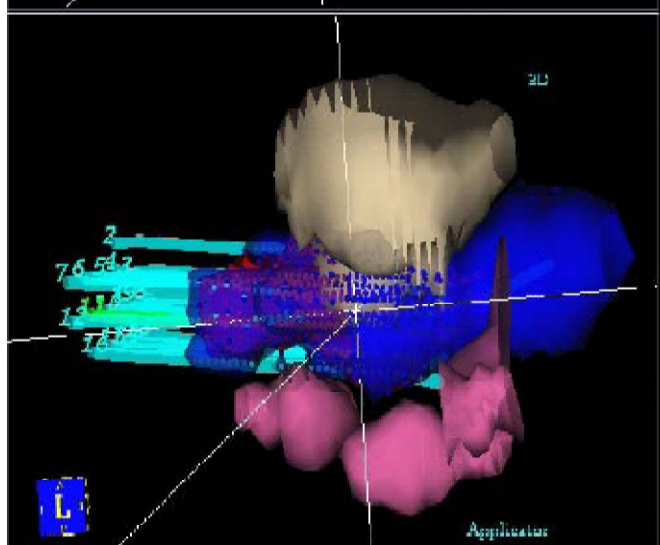
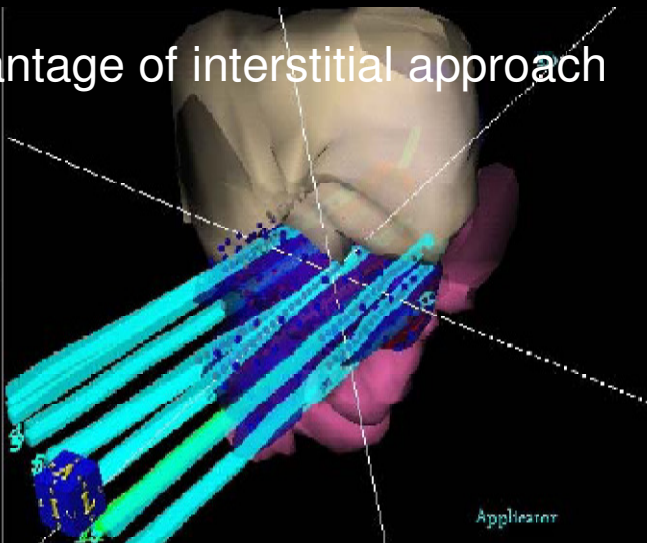
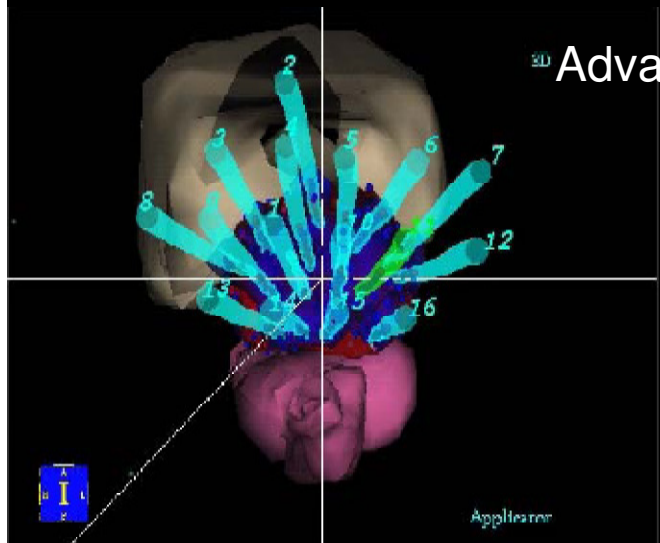


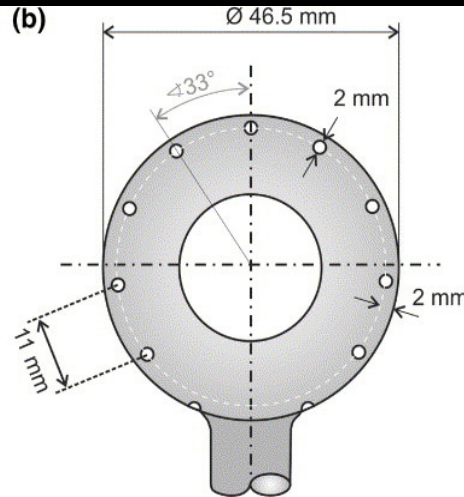
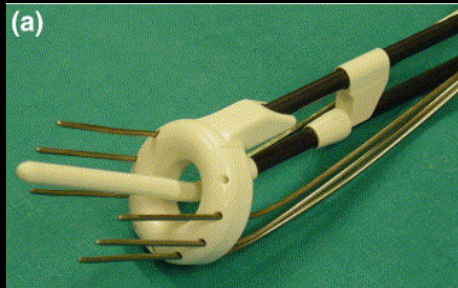
Three Dimensional Dose Distribution with MUPIT



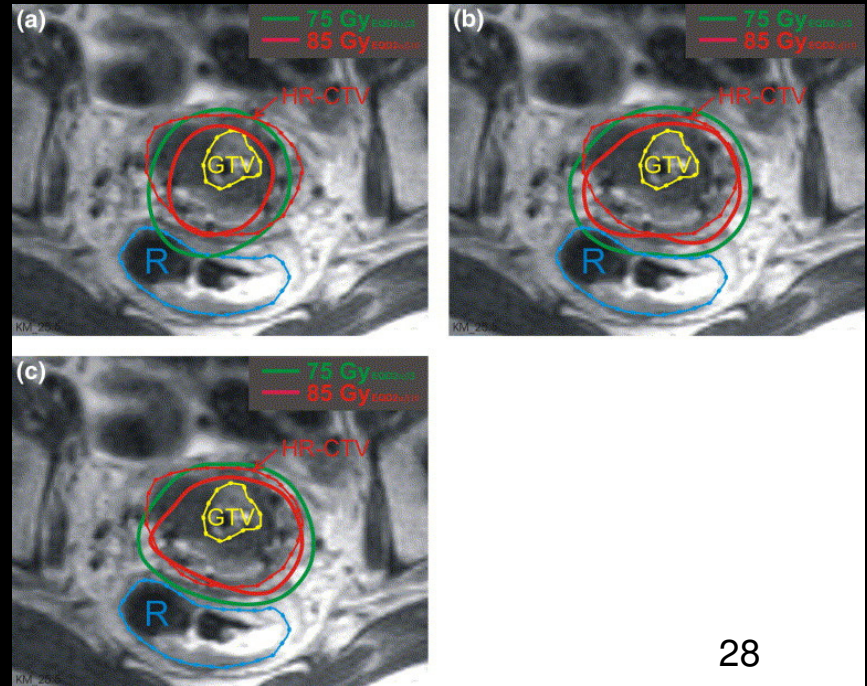
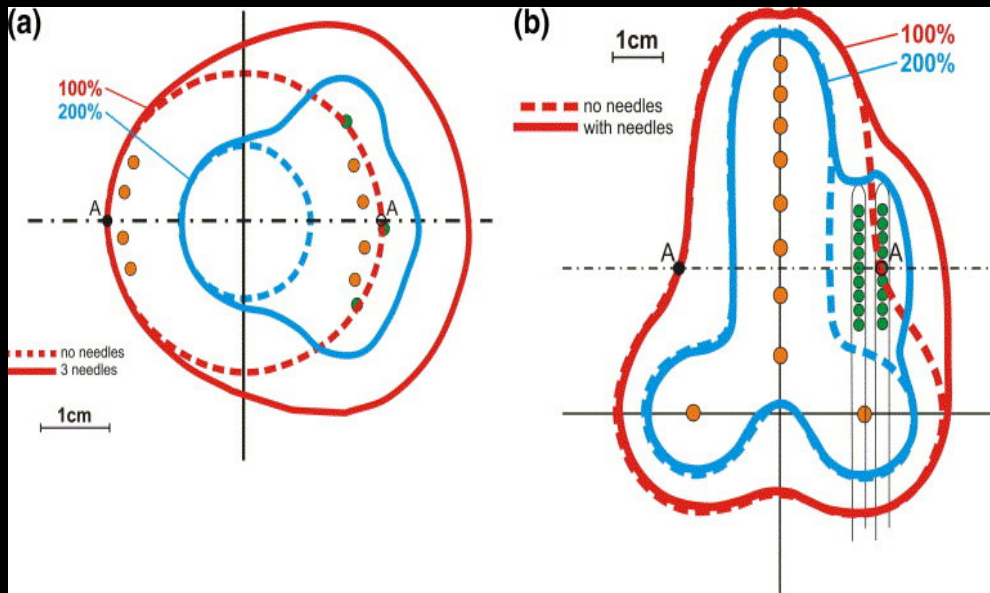
Advantage of interstitial approach ICB + Interstitial brachytherapy

3D Advantage of interstitial approach



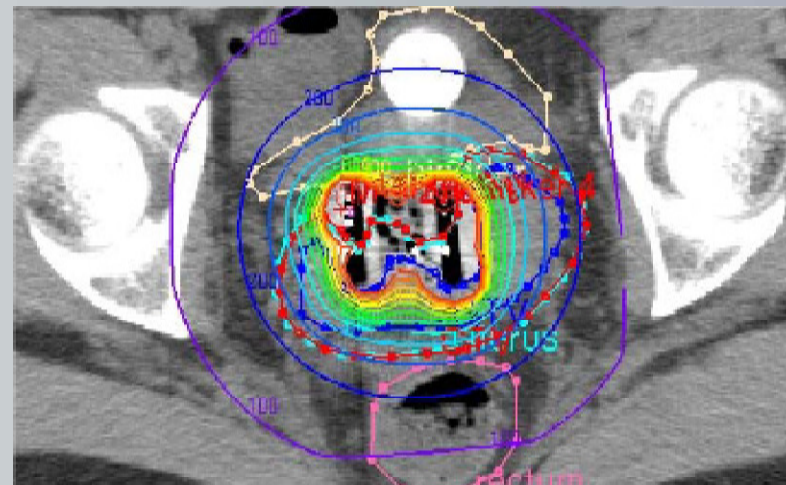
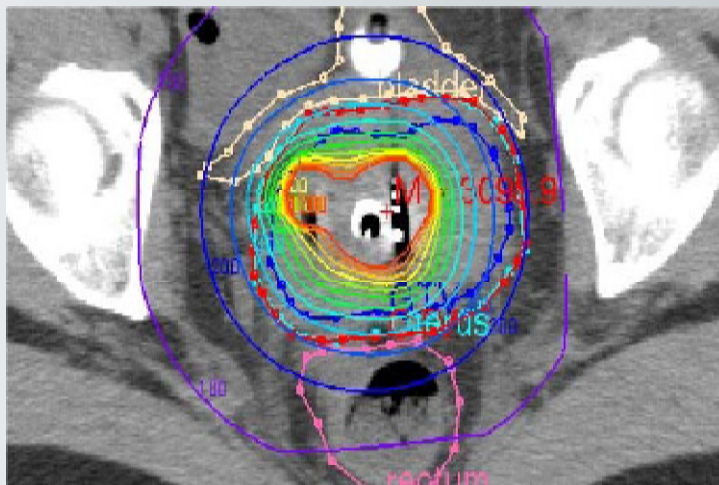
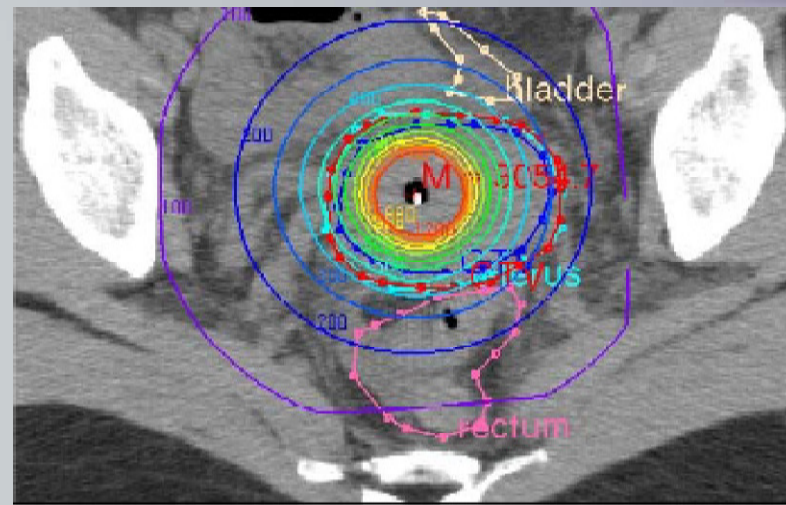
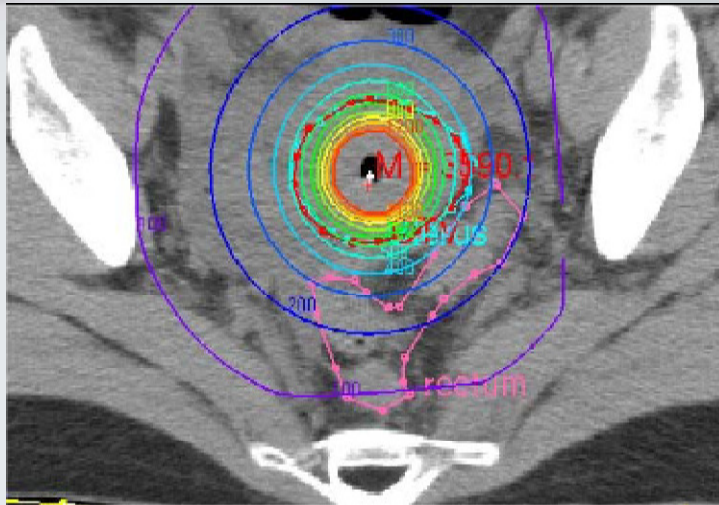


(a) The standard loading of the tandem and ring with prescription to point A shows insufficient coverage of the HR CTV (D90: 5.7 Gy, V100: 75%). (b) Loading of three needles available on the right and two needles on the left improves target coverage to 92%. By using this plan, the D2cc for the rectum would be $>4.9 \text{ Gy}$, thus exceeding the total dose constraint of $75 \text{ Gy}\alpha\beta 3$. (c) In the final plan, the dwell weights are adjusted to achieve 91% HR CTV coverage (D90: 7.1 Gy prescribed dose) and 4.4 Gy for the D2cc to the rectum. One additional implanted needle on the right ventral side of the HR CTV further increased the dose to the target during the following three fractions.

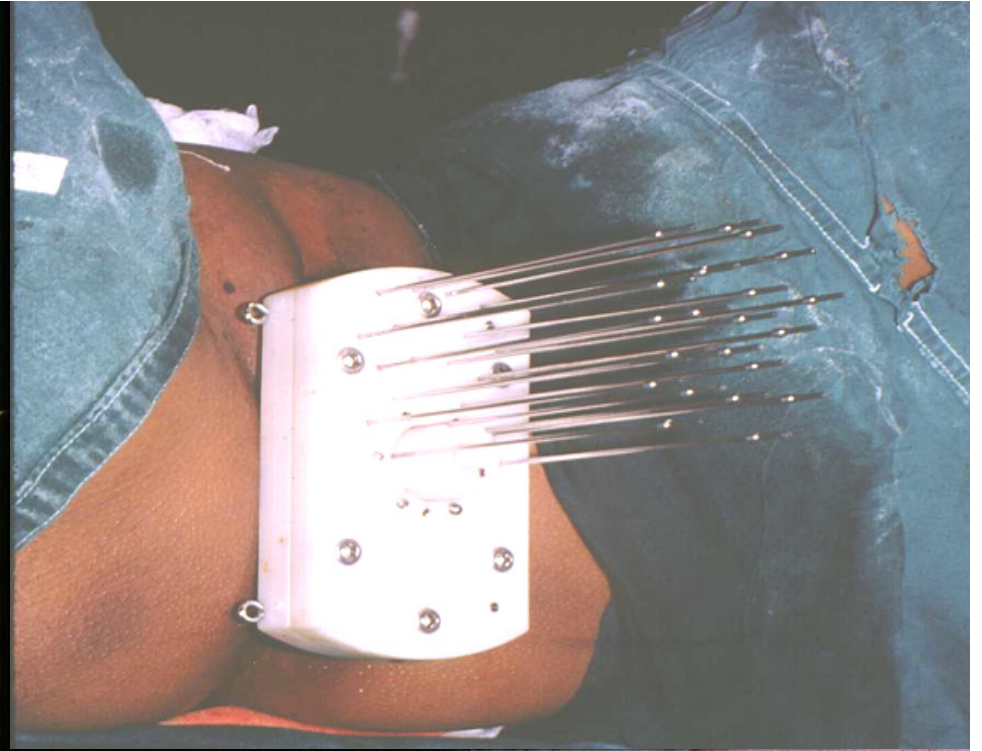




Advantage of interstitial approach



Not enough coverage of the tumor by typical ICB



Urethral + Clitoris Lesion



Comparison of series using interstitial implants

| Study | N0: of patients | Type of implant | EBRT dose | Brachy dose | Median FU | Local tumor control | Gr 3-4 late toxicity |
|---------------|-----------------|-----------------|----------------|-------------|-----------|---------------------|----------------------|
| Demanes | 62 | Syed Neblett | 36Gy + 14GyMLB | 6Gyx6# HDR | 40 mths | 94% | 6.5% |
| Gupta | 69 | MUPIT | 39GY | 32Gy | 30 mths | 60% | 14% |
| Nag S | 39 | Syed Neblett | 50Gy | 30Gy | 36 mths | 48% | 2.5% |
| Martinez | 63 | MUPIT | - | - | 36 mths | 83% | 3% |
| Hughes-Davies | 139 | MUPIT | 42Gy | 30Gy | 57 mths | 25% | 17% |
| Monk BJ | 70 | Syed Neblett | 50 Gy | 41Gy | 58 mths | 32% | 21% |



Interstitial Brachytherapy Retrospective analysis

N= 39

- **Post Hysterectomy Ca.Cx / Vault Recc : 21 (54%)**
- **Ca.Vagina : 18 (46 %)**
- **Treatment Protocol : RT +/-CT (weekly cisplatin)**
 - **XRT : 45-50 Gy / 25 # / 5-6 wks.**
 - **MUPIT : 3.5-4 Gy / # @ 2 # / day total 4-6 #**
- **Toxicities**
 - **Procedure related : Nil**
 - **RT related : Gr II : small bowel (2 pts) ; rectal (1 pt)**

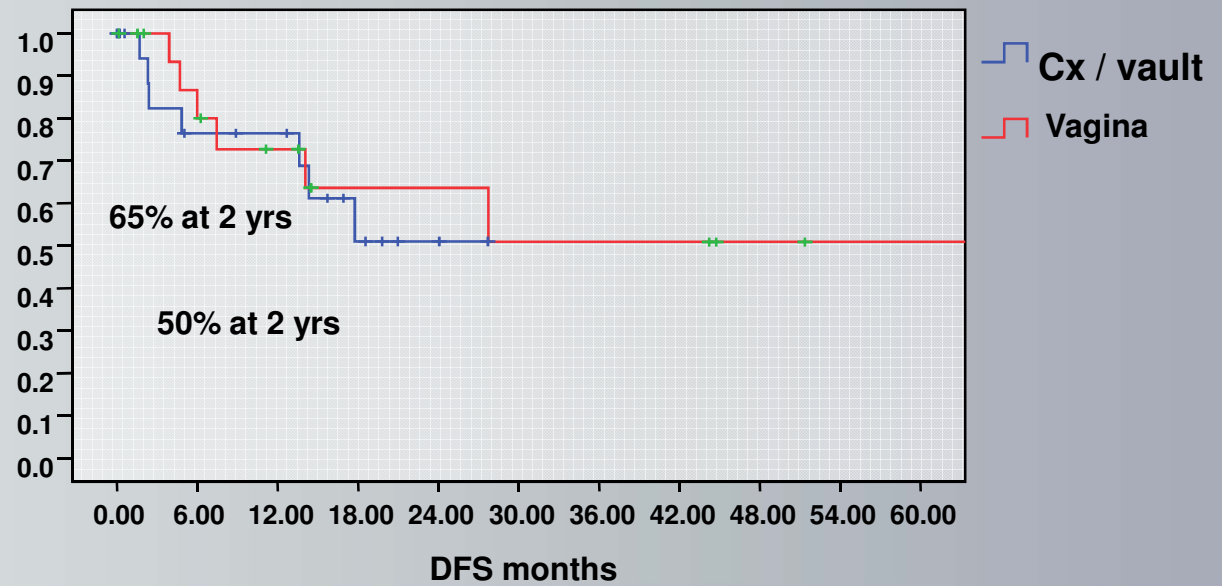


Treatment Outcome N = 39

- Median Follow-up : 16 months (10 -104 months)

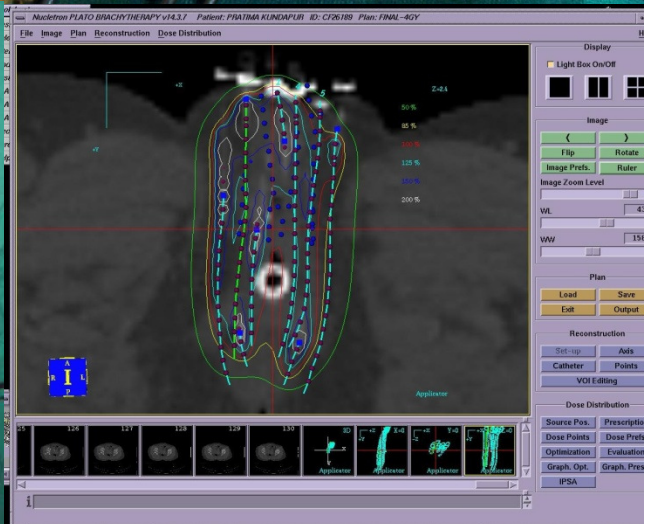
- Loco-Regionally Controlled : 24 (62%)
- Persistent Disease : 1 (2.5%)
- Central Recurrence : 10 (25%)
- Loco-Regional Recurrence : 3 (7%)
- Distant Metastasis : 1 (2.5 %)

Disease free Survival





Ca Vulva





Tata Memorial Hospital Experience

Period: 2000 - 2010

17 patients

| | Radical Brachy (n=6) | EBRT + Brachy (n=11) |
|---------------------|---------------------------|--------------------------|
| Brachy Dose | Median 38Gy | Median 20Gy |
| EBRT dose | NA | Median 50Gy |
| HDR Brachy (2#/day) | 3.4 - 4 Gy/# for 8 – 12 # | 3.4 - 4 Gy/# for 4 – 5 # |
| Median OS (mnths) | 62 (12 – 102 mths) | 33 (10 – 122 mths) |

- Median age : 59 years (Range: 33 to 77)
- Brachytherapy techniques:
 - Needle + plastic tube : 9 pts [Median tubes : 8 (4 - 12)]
 - Template Based : 8 pts [Median tubes:13 (11 - 20)]
- 4 Patients received treatment after radical surgery
- Status at last follow up: 2 pts necrotic ulcer at post. fouchette (disease)
 - 1 pt expired at 38 months follow-up
 - 3 patients alive with disease (status of others not known)



Selection Criteria Permanent Brachytherapy PROSTATE

Brachytherapy as
monotherapy

Brachytherapy as boost to
EBRT

T Stage

| | | | |
|----|---------|---------|---------|
| T1 | T2 a | T2 b | T2 c |
|----|---------|---------|---------|

Gleason's

| | |
|-----|------|
| 2-6 | 8-10 |
|-----|------|

PSA

| | |
|------|------|
| < 10 | > 20 |
|------|------|



Prostate Brachytherapy

Permanent and Temporary.

Perineal, Retropubic and suprapubic approaches

A. Perineal approach

Needles are introduced above the anus and are guided into the prostate with the index finger in the rectum.

B. Suprapubic Cystotomy Approach

The needles are placed directly in the prostate through the open bladder with a finger in rectum guiding the placement.

C. Retropubic approach

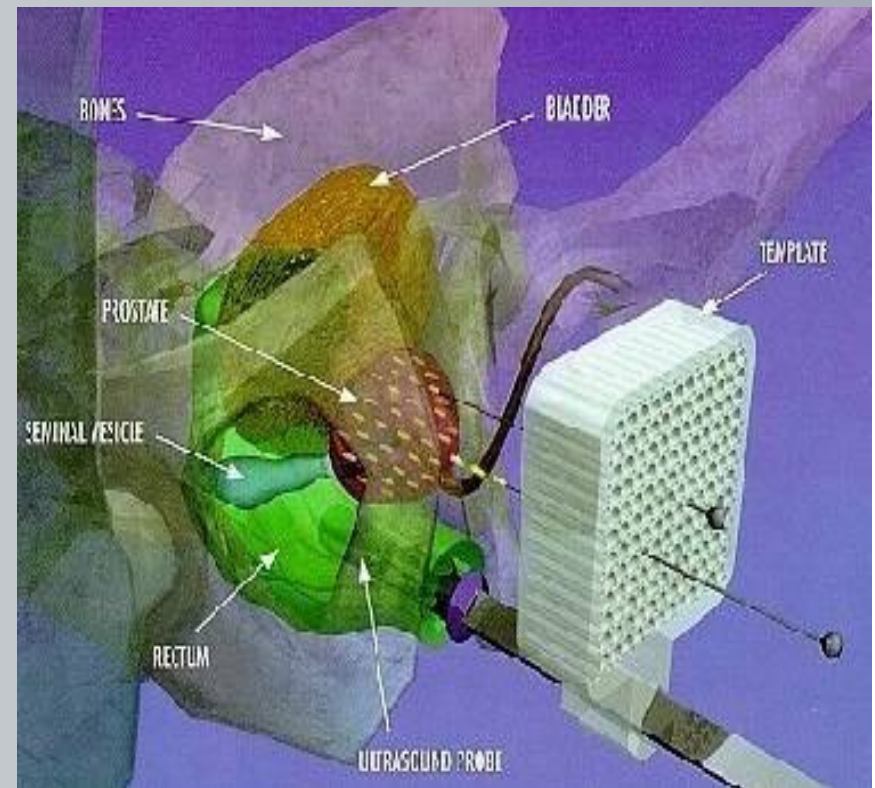
This approach is used most extensively, though it's a more difficult procedure.



Prostate Brachytherapy

Basic Steps Permanent Seed brachytherapy:

- Assess prostate volume → CT / USG
- Determine total activity to encompass gland
- Deliver appropriate minimum peripheral dose
- Determine pattern of placement of seeds

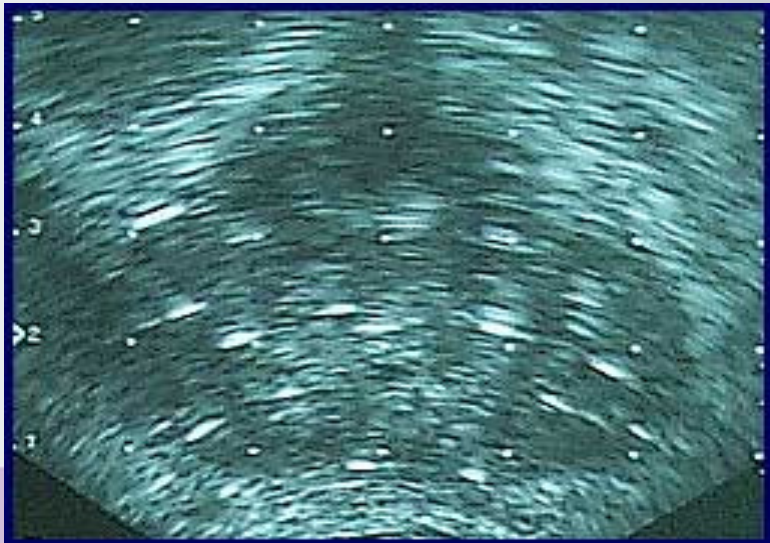




Prostate: Mick's Applicator



"The Optimal Afterloading" & Real Time Design Prostate Seed Implant Delivery System" for Pd-103 and I-125 Seeds !





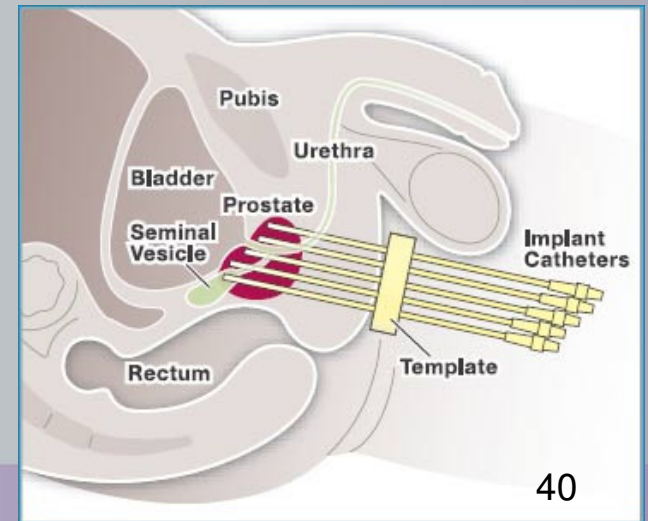
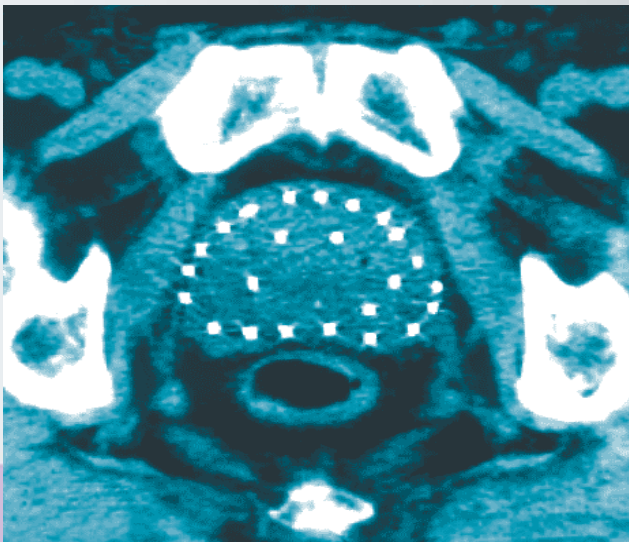
PROSTATE BRACHYTHERAPY

PERMANENT
(SEED BRACHY I125/ Pd103)

TEMPORARY
(HDR NEEDLE IMPLANT)

MONOTHERAPY
(LOW RISK)

COMBINED WITH EBRT
(INTERMEDIATE AND HIGH RISK)





Dose reporting

- **The prescription, including**
 - prescribed dose,
 - Dose rate,
 - Implant duration,
 - Radionuclide used,
 - sources' strengths, and
 - loading pattern;
- Type of applicator used;
- Volume encompassed by prescribed isodose surface;
- MSD; and
- Rectal and bladder doses, if assessed.

ABS IJROBP 2002



CONTRAINDICATIONS FOR INTERSTITIAL PERINEAL BRACHYTHERAPY

General Contraindications:

1. Risks for GA/ Epidural anesthesia due to medical reasons.
2. Technically difficult to get coverage dose
3. Distant metastases.

Specific Contraindications:

- **Gynecological**

1. Residual disease upto lateral pelvic wall.
2. Disease infiltrating rectovaginal septum /posterior bladder wall at the time of brachytherapy.

- **Gastrointestinal**

1. Circumferential lesions.
2. Long Longitudinal length
3. Avoid implanting large volume residual lesions.

- **Prostate**

1. Large /poorly healed TURP defect (Stricture, incontinence....)
2. Large prostate (>60 cc relative CI)
3. Previous irradiation, Multiple surgeries.



Thank You

