INTRACAVITARY BRACHYTHERAPY

MODERN DAY APPLICATORS AND TECHNIQUES

FOR

CERVICAL CANCERS

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Radiotherapeutic Management of Cervical cancer

TREATMENT PRESCRIPTION - PLANNING AIM

- **RADICAL CHEMO-RADIATION** with EBRT & BRACHYTHERAPY (BT)

- **EXTERNAL BEAM RT**
  - **EBRT TECHNIQUE:** CONVENTIONAL / CONFORMAL / IMRT/VMAT……
  - **SIMULATION:** CONVENTIONAL / CT BASED
  - **DOSE:** 45 - 50 Gy / 25# @ 5# PER WEEK in 5 - 6 weeks

- **CONCOMITANT CT:** CISPLATIN 40 mg/m2 x atleast 5 Cycles

- **BRACHYTHERAPY BOOST:** High Dose Rate BT with 7 Gy TO POINT ‘A’ ONCE WKLY x 4 # STARTING FROM 4-5 WEEK ONWARDS

- **OTT:** < 7 - 8 weeks
Treatment Prescription for Cervical Cancer

Concomitant chemoradiation
Planning Aim (External + BT)

• Concurrent Cisplatin CT 40 mg/m2 once weekly x atleast 5 cycles

• Tumoricidal Doses (All doses in EQD2)
  - For primary: 85 – 90 Gy (External + Brachytherapy doses)
  - Pelvic / Parametrium external boost (optional): 50-55 Gy
  - Nodes: 45 -50 Gy (External) +/- Boost (N+ disease)

• External Beam : 45 – 50 Gy @ 1.8 – 2 Gy per fraction

• Brachytherapy (Fractionated HDR Schedule)
  - 3 - 4 # of HDR boost @ 7 Gy to Point A / HR-CTV

• OAR’ s : Rectum / Sigmoid: 70 -75 Gy EQD2
  Bladder : 90 - 95 Gy EQD2
FIGO (2018)

T  N  M

\( h = \underline{\phantom{5}} \text{cm} \quad t = \underline{\phantom{5}} \text{cm} \quad \text{NMD (R)} = \underline{\phantom{5}} \text{cm} \quad \text{NMD (L)} = \underline{\phantom{5}} \text{cm} \quad w = \underline{\phantom{5}} \text{cm} \) (NMD = Near Maximum Distance)

**Local Disease Documentation & Mapping**

- Initial evaluation
- At brachy (fraction no.____)

**Patient Initials**: 

ID: 

**Vaginal Disease**

- Ant: \( \underline{\phantom{5}} \) cm
- Post: \( \underline{\phantom{5}} \) cm
- Rt Lat: \( \underline{\phantom{5}} \) cm
- Lt Lat: \( \underline{\phantom{5}} \) cm

**BT Category**: \( I_{BT} / II_{BT} / III_{BT} / IV_{BT} \)

**Remarks**: 

**Signature & Date**: Mahantshetty et al; J. CON. BRACHY AUG 2019; 293 - 306
Message 1: Clinical Examination & documentation using Revised Clinical Drawings

Patient Initials:  ID: 33422-CN(SD)-TATA 04

- Initial evaluation
- At brachy (fraction no_

\( h = \_
\( t = \_
\( NMD (R) = \_
\( NMD (L) = \_
\( w = \_

(NMD = Near Maximum Distance)

Vaginal Disease
- Ant: 0 cm
- Post: 1 cm
- Rt Lat: 1 cm
- Lt Lat: 0 cm

FIGO (2018)
- T 3b
- N 1
- M 0

\( \text{BT}_{\text{category}}: I_{\text{BT}} / II_{\text{BT}} / III_{\text{BT}} / IV_{\text{BT}} \)

Remarks: Cystoscopy: Negative
- On MR: RT Obturator node: 10mm, no other nodes

Signature & Date: UMM 07.11.2016

Mahantshetty et al; J. CON. BRACHY AUG 2019; 293 - 306
Patient Selection- Brachytherapy

- Brachytherapy boost is planned towards the end or after completion of external beam radiation therapy (*Respect the Overall treatment time!*)

- Pelvic examination to assess suitability for brachytherapy application

- **Brachytherapy Procedure Pre-requisites:**
  - Review for fitness to undergo anesthesia
  - Medical Comorbidities (For Ex: Cardiac Issues, Long standing hypertension, H/O DVT:: *Trail of Investigations & delay in BT*)
  - Pelvic anatomy and tumor topography suitable for appropriate applicator placement

- **Pre-planning:** Tumor topography, Imaging & availability of applicators
  - Lie of the Uterus, Size of Uterus (Thick/Thin), Presence of Fluid in the cavity, large fibroids, Cysts (*No surprises during procedure!*)

Quantitative tumor regression

EBRT: tumor regression 75%
Brachytherapy: tumor regression 10%

Easy to predict

Dimopoulos et al. Strahlenther Onkol 2009
Anesthesia for Brachytherapy Procedure

- **Principle:** Adequate relaxation for cervical dilatation, vaginal packing & application reproducible esp. in fractionated HDR

- **Short General Anesthesia:** preferred for proper application especially if many procedure lined up

- **Spinal Anesthesia with Epidural Analgesia:** is also an effective alternative

- If patient high risk for general / spinal anesthesia:
  - Sedation and analgesics
  - Regional Blocks: Obturator blocks
  - Local blocks: Para-cervical blocks

**Message 3:** Short General or Spinal Anesthesia mandatory irrespective of type of BT application
Principles of BT application

Cervical Cancer
Post EBRT + Cis Chemo

Intact uterus
- No residual disease
- Residual disease limited to cervix & immediate para-cervical tissues
- Residual disease at cervix limited to medial parametrium and/or upper vagina
- Residual disease extending to distal parametrium and/or lower vagina

Post-hysterectomy (Vault/ Vaginal recurrences)
- No residual disease
- Residual disease confined to central vault
- Residual disease at vault extending to paracolpos/parametrial tissue

BT Category I
BT Category II
BT Category III
* BT Category IV is with organ involvement irrespective of BT I-III
Message 4: BT Planning Process – Basic understanding & Implementation
Brachytherapy Planning

• **Brachytherapy**: EUA, Appropriate Applicator placement

• **MR Imaging**: Bladder protocol, T2 axial, sagittal, coronal (3-5mm with 1mm)
  
  *(GEC-ESTRO RECOMMENDATION-IV)*

• **Contouring**: Targets (GTV-B, HR-CTV, IR-CTV & OAR’s (Rectum, Bladder, Sigmoid, Small Bowel))
  
  *(GEC-ESTRO RECOMMENDATION-I)*

• **Planning**: TPS (Brachyvision / Oncentra / Plato)
  
  - Catheter reconstruction *(GEC-ESTRO RECOMMENDATION-III)*
  
  - Loading pattern (Std with Needles ratio)
  
  - Optimization (Manual / Inverse)

• **Plan evaluation**: EQD2 values
  
  *(GEC-ESTRO RECOMMENDATION-II)*
  
  - Doses to HR-CTV, GTV (D90, D100, V100 etc…)
  
  - Doses to OAR’s (rectum, bladder, sigmoid 0.1 cc, 1 cc, 2cc)
BT Technique & Applicators

Type of BT Technique

Intracavitary BT (ICBT)

Combined intracavitary & interstitial BT (ICIS)

Interstitial BT (ISBT)

Venezia Applicator

Tandem - Ring with needles/tubes

Tandem - Ovoid with tubes

Venezia Applicator

Tandem-Ovoid

Tandem-Ring

Indigenous TMH Templates

MUPIT
Message 5: STANDARD PEAR – Basic understanding & Implementation

LIMITED RESIDUAL DISEASE

EXTENSIVE RESIDUAL DISEASE
Dimensions of prescribed dose: different levels

Standard loading

Prescribed dose

Level

- A + 2 cm
- Point A
- 1 cm below Point A
- Ring sources

Example:
Tandem & Ring applicator:
30 mm ring & 60 mm tandem
Mission

Modern Manchester Applicator

Modern Stockholm Applicator

Ring applicator

Mould Applicator

Population Target Vol.

75%
95%
100%

264 patients

Petric P, et al. GEC ESTRO, Porto 2009, Supported by Varian

Courtesy: P. Petric, D. Berger
Modern Intracavitary BT Applicators
STD IC Versus IC + IS Principles

STD Pear Distribution

IC + IS Distribution
Advanced BT Procedure – Basic Instrumentation Set-up

- **Radio-opaque 2-3 mm in length & < 1 mm diameter**
- Implanted into tissue with the help of spinal needle
- Tissue interactions: Nil, hence need not be removed

- **Dilators**
- **Sim’s Speculum**
- **Asepto syringe**
- **Uterine sound**
- **Foley’s catheter**
- **Silver Markers**
- **Radio-opaque gauze pack**

**Applicator Tray**
Eg. Vienna Applicator
ADVANCED BT TECHNIQUE (for eg. using Vienna Applicator) - PROCEDURE PRINCIPLES

1. Bladder Catheterization & use of Aspeto syringe
2. Pelvic examination
3. Uterine tandem insertion confirmed by Trans-abdominal US
4. Uterine canal sounding & dilatation
5. Bladder Catheterization & use of Aspeto syringe
6. Pelvic examination
7. Uterine canal sounding & dilatation
8. Bladder Catheterization & use of Aspeto syringe
9. Pelvic examination
10. Uterine canal sounding & dilatation

- Ring insertion & locking
- Needles insertion & Trans-rectal US guidance
- Vaginal Packing
- Packing & fixation to perineum
Customization – IC + IS Application using Free hand needles & rubber tube

- After STD Intracavitary application
- Insert rubber tube with needles lateral to ovoids
- Push each needle into the tissues for 4-5 cm only
- Ensure no migration of needles during vaginal packing
Modified Vienna Ring

Advanced needle Guiding Template

Pre-bended needles

Approximately 60 patients experience: Vienna & Mumbai

Venezia Applicator

Applicator for distal parametrial disease

Advanced IC + IS Principles

Vienna-II ring applicator for distal parametrial/pelvic wall disease in cervical cancer brachytherapy: An experience from two institutions: Clinical feasibility and outcome

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Abstract

Purpose: Recent evidence from ENBRACE shows that around 165 patients with locally advanced cervical cancer (LACC) have residual tumor in the parametrial region (PR) and pelvic wall disease (PwD) after concurrent radiotherapy-brachytherapy (CRT2). Apparatus setup needs to be standard brachytherapy approaches represent a challenge. Therefore, we modified the Venezia applicator with an add-on cap allowing for additional unique needles (V-FLARE, Vienna- II). We report here the feasibility and clinical outcomes using such applicator at LACC patients treated in a phase III clinical trial.

Material and methods: To date 60 patients have been treated (50/60 PR-patients, stage was 20B, 30% B, 70% B2, 70% PwD (para-aortic nodes). At diagnosis 15% had disease involving PR (DwPwD), 40% CRT, patients underwent image-guided adaptive brachytherapy (IGBT) using Venezia & modified Venezia (V-FLARE cap). Applicator modifications and clinical outcomes are evaluated.

Results: In the modified Venezia applicator, the mean number of needles used were 22 (range 15-32), dwell time was 500 s, mean dose to PR was 20 Gy EUD. 70% of patients with DwPwD were treated with IGBT. Overall survival at 3 years of patients treated with IGBT was 75%.

Conclusion: The IGBT technique is feasible and safe in this population of patients when using the modified Venezia applicator.
STD Pear Distribution

STD IC Versus IC + IS Principles

IC + IS Distribution with straight needles

IC + IS Distribution with straight and oblique needles

<table>
<thead>
<tr>
<th>Physical distance between tandem and needle</th>
<th>Needle loading in relation to intracavitary</th>
<th>Distance: tandem to prescribed isodose line on level of point A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intracavitary only</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No needles</td>
<td>0%</td>
<td>20 [15-25] mm</td>
</tr>
<tr>
<td>+ Parallel needles 20mm</td>
<td>10-20%</td>
<td>25-35 mm</td>
</tr>
<tr>
<td>+ Oblique needles 20° (23-27mm)</td>
<td>5-10%</td>
<td>35-40mm</td>
</tr>
</tbody>
</table>

Vienna-II

Vienna-I

3.5 Gy
5 Gy
7 Gy
14 Gy
Latest Development in Applicators

VENEZIA GYN APPLICATOR
Petric P, et al. GEC ESTRO, Porto 2009, Supported by Varian

Modern Stockholm Applicator
Modern Manchester Applicator
Ring applicator

Utrecht
Venezia
Vienna

Population Target Vol.
75%
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VENEZIA Mission
264 patients

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Courtesy: P. Petric, D. Berger
Brachytherapy Techniques

• Choice of appropriate technique depends on:
  - residual tumor topography at brachytherapy
  - availability of brachytherapy applicators
  - availability of expertise

• In General: depending on residual disease at brachytherapy
  - Disease confined to cervix and immediate para-cervical tissues: IC alone (Category I)
  - Extensions into/ beyond medial third parametrium: IC + IS combination (Category II)
  - Extensive disease not amenable to IC + IS: IS (Category III)

• Applications can be modified in subsequent fractions (esp. HDR)

Message 5 : Appropriate type of BT application important for optimum local control rates
Workflow for 3D Image Based Brachytherapy Planning

**2D BT**
- Fletcher
- Orthogonal X Rays

**Brachy Procedure**
- Applicators
- Imaging
- **Contouring**

**3D BT**
- CT/MR Compatible IC+IS
- CT/MR. Contrast
- Target/OARs

**Applicator Commissioning**
- **Applicator Reconstruction**
- Definition of Dose Points
- Planning
- Plan Evaluation
- Dose Delivery

**Target/OARs**
- HRCTV, D2cc, Point A, ICRU pts
- Std Loading, Manual/Graphical Opt, IP
- GEC-ESTRO DVH Parameters
1. Catheter Reconstruction

(GEC-ESTRO RECOMMENDATION - III)
Applicator Reconstruction: Physicist

Inaccuracy in applicator reconstruction can lead to geometrical uncertainties and thus uncertainties in the definition of source positions which influence the accuracy of the delivered dose to both target volumes and organs at risk.

- Direct reconstruction: MPR
- New method: Applicator library

2. Pt ‘A’ Definition for different IC Systems

3. ICRU- B & RV (ICRUR) Points

Vaginal points:
- High dose points
- PIBS, PIBS + 2 & PIBS - 2 points
Treatment Prescription for Cervical Cancer
Concomitant chemoradiation
Planning Aim (External + BT)

• Concurrent Cisplatin CT 40 mg/m2 once weekly x at least 5 cycles

• Tumoricidal Doses (All doses in EQD2)
  - For primary: 85 – 90 Gy (External + Brachytherapy doses)
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• OAR’s : Rectum / Sigmoid: 70 -75 Gy EQD2
  Bladder : 90 - 95 Gy EQD2
Indian Brachytherapy Society Guidelines for radiotherapeutic management of cervical cancer with special emphasis on high-dose-rate brachytherapy

Mahantshetty et al; J. CONT. BRACHY AUG 2019; 293 - 306