HDR Gynecologic Applicators Overview
Partners in Solutions

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Overview

- Overview of Gynecologic Cancers
- The role of brachytherapy in GYN Cancers
- Overview of GYN HDR Applicators
- The move from point based planning to IGBT
- Commissioning of Applicators
Gynecologic Cancers

Vulva  Cervical  Vaginal  Uterine/Endometrial  Fallopian Tubes  Ovarian
Cancer Incidence

United States Annual Incidence GYN Ca: 94,000

Estimated number of incident cases worldwide, females, all ages

- Breast: 569,847
- Lung: 382,069
- Cervix uteri: 295,414
- Corpus uteri: 382,069
- Ovary: 295,414
- Rectum: 
- Liver: 
- Colon: 
- Stomach: 
- Thyroid: 
- Sum: ~1.25 Million

Data source: GLOBOCAN 2018
Graph production: Global Cancer Observatory (http://gco.iarc.fr/)
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Brachytherapy and Cervical Cancer

SEER Data

Overall Survival

Brachytherapy Usage

4 Year OS: 58 vs. 46%

83% - 1988

58% - 2009

Han et al. IJROBP, 87(1), 2013
Brachytherapy or SBRT
National Cancer Database

Overall Survival

Brachytherapy/SBRT Usage

Gill et al. IJROBP, 90(5), 2014
Total treatment time

1% per day loss of local control & OS for tx time > 52 days
GYN Brachytherapy Evolution

1920’s
- Low dose rate systems
- Stockholm, Manchester, and Paris
- Standardized loading
- $\text{mgRa/hr}$
- Treatments times of 1-5 days

1950’s
- Introduction of “customization”
- Points A and B are surrogates for cervical target / obturator LN respectively
- Not planning to the disease

1980’s
- ICRU 38: a new reporting system is needed
- Intro of HDR and PDR
- TPS
GYN Brachytherapy Evolution

2000+

- Use of LDR diminishes and HDR increases
- Improved TPS
- Movement away from classical dosimetry systems towards patient specific dosimetry with imaging (IGBT)
Why so Many Applicators???
Cervical Cancer Staging

Brachytherapy a recommended component
Heterogenous presentation – array of applicators needed

Vaginal Cuff Brachytherapy

Vaginal cylinder is the most commonly used applicator for Vaginal cuff brachytherapy

**Single Channel**

**Multi-Channel**
Types of Applicators for Cervix
T&O / T&R

“Classic Pear”
Standard Loading
~80% Tandem
~20% Ovoids/Ring

Modified Pear
Patient Specific
Interstitial Applicator
Hybrid Applicators
T&O/T&R + Needles
p > 0.05 for all OAR’s

Fokdal et al., Radio & Oncology, 120(3), 2016
Plan Evaluation
Items to Consider

Similar coverage but 150% is different
Point Based Planning

Dose points are based on anatomical landmarks and applicator geometry

**Imaging:** Can use orthogonal or 3D images

**Pros of Point Based Planning:**
- Widely available
- Can be more efficient (less/no contouring)

**Cons of Point Based Planning:**
- Does not implement modern imaging of GTV/CTV/HRCTV
- Potential underdosing of tumor
- Potential underdose of OAR’s
- Doses highly dependent upon subtle differences in applicator geometry
Benefits of IGBT

Image Guided Brachytherapy

**Imaging:** 3D images

**Pros of Point Based Planning:**
- Potential for differentiation between uterus, peri-uterine tissues, and tumor.
- Accurate visualization of applicator position
- Ability to shape the dose distribution around the tumor while avoiding actual OAR’s (and not just points representing OAR’s)
- Opportunity for dose escalation

**Cons of Point Based Planning:**
- May be less efficient
- Reliance on the accuracy of contours
- Learning curve?
Point A vs IGBT

Pt A Planned
Overdose of OAR’s
(i.e. Sigmoid)

IGBT
Appropriate coverage of target
Lower sigmoid dose

“SIB” Type IGBT
IGBT Society Recommendations

Image Guided Brachytherapy

ABS (2012): ABS consensus updates on cervical cancer including recommendations for CT/MRI imaging and planning with each insertion

GEC-ESTRO (2012): Recommendation for MRI prior to tx and with first brachytherapy with applicator in place. T2 images are preferred.

ICRU 89 (2016): MRI to be the reference standard ("Gold Standard") for GYN tumor assessment.
  Minimum reporting guidance
  Tiered reporting guidance
Imaging Options - CT

Pros
- Typically don’t need special applicators
- Catheters are easy to see and reconstruct
- Fast.
  Aids turnaround times and efficiency
  Reduced artifacts due to patient motion

Cons
- May need to move patient
- Patient size/bore limitations
- Inferior imaging for contouring
  Example: fails to provide differentiation between uterus, peri-uterine tissues, and tumor
Imaging Options - MRI

Pros
- Superior imaging with excellent soft tissue differentiation

Cons
- Scheduling of the MR
- Often need to move patient
- Longer scan times
  - Inefficiency
  - Motion artifacts
- Specialized applicators and dummy markers (MRI compatible)
- Catheters can be more difficult to visualize
- Patient size /clearance issues
- MRI susceptibility distortions (≤3T generally ok)
- Reconstruction is more challenging than on CT
CT and MRI Comparison

CT

MRI
Challenging Reconstruction
Patient Motion Artifacts

Crisp Images
Catheters easily identified

Challenging Images
Catheters more difficult to identify
Challenging Reconstruction

Small void around ovoids
Commissioning

- Visual inspection of all parts and components
- Radiographic inspection of all parts to look for cracks, etc…
- Commission dummy markers (if not already in use)
- Commissioning of all components with dummy markers
- Validate lengths
- Test Plan
- Policies and Procedures (including planning and treatment)
Brachytherapy plays a critical role in the treatment of many gynecologic cancers.

Variations in the disease presentation dictates the need for a variety of applicators.

While point A provides historic dosing information, there is a need to move to IGBT.

Robust applicator commissioning must be conducted to ensure safe treatments.