

Dosimetric study of interstitial brachytherapy for gynecological malignancies

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SUMMARY

Annual incidence of Carcinoma Cervix is around 570,000 worldwide. Carcinoma Cervix is fourth leading cause for cancer death in women worldwide. Global annual incidence of Carcinoma Vagina is around 18,000. In cervical cancer patients clinical outcome has improved with intracavitary Brachytherapy. Most common site treated with Brachytherapy is Carcinoma Cervix as per the survey done by American Brachytherapy Society (ABS). In management of Carcinoma Cervix Brachytherapy plays a crucial role. Intracavitary Brachytherapy (ICBT) is the most commonly used technique. In cases where ICBT is not technically feasible or it may result in suboptimal dose distribution, Interstitial Brachytherapy (ISBT) is recommended. The most common technique for ISBT is perineal template based implant procedure.

Key words: dosimetric, brachytherapy, gynecological malignancies

INTRODUCTION

In Radiation treatment of vaginal tumors both primary and recurrent cases, Brachytherapy plays a crucial role [1]. After external beam radiation to pelvis, a brachytherapy boost is used to treat vaginal cancers. Primary and recurrent cancers in the vagina are often treated with a brachytherapy boost after external beam radiation to the pelvis [2, 3]. Brachytherapy delivers high-dose radiation to tumors due to the ability to place the source in close proximity or inside the target [4-6]. Commonly used Brachytherapy techniques in vaginal tumors are Single-Channel Vaginal Cylinder (SCVC) and ISBT. ISBT is the preferred modality for vaginal cancer lesions thicker than 5 mm as per recommendations of American Brachytherapy Society [7].

Various interstitial templates like Martinez Universal Perineal Interstitial Template (MUPIT) and Syed Neblett template are used in clinical practice for gynecological malignancies [8, 9]. With this study we intent to assess the dosimetric details of Interstitial Brachytherapy for gynecological malignancies done in our institution.

METHODOLOGY

Aim

- To assess dosimetric data of interstitial brachytherapy for gynecological malignancies

Objective

- To assess the Organ At Risk (OAR) doses as per GEC-ESTRO (Groupe Europeen dee Curietherapie- European Society for Therapeutic Radiology and Oncology) guidelines (D2cc, D1cc and D .1cc)
- To assess the EQD 2 doses to OARs
- To assess the D90 and D100 (dose to CTV)

Materials and methods

- Study setting-Department of Radiation oncology in a rural tertiary Cancer Centre in Kerala, India
- Study type-Retrospective study
- Study population-Patients who underwent interstitial brachytherapy for gynecological malignancies from 1st

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January 2013 to 31st July 2019

Inclusion criteria

- All patients who underwent interstitial brachytherapy procedure for gynecological malignancies from 1st January 2013 to 31st July 2019

Exclusion criteria

- Those patients whose details cannot be retrieved from treatment planning system

Interstitial brachytherapy procedure

Clinical and imaging findings prior to EBRT and brachytherapy were used to estimate tumor volume and number of needles required for implantation. While under general anesthesia/Epidural anesthesia and the patient is in lithotomy position, pelvic examination was performed to evaluate extent of residual disease. A foley catheter was placed in the bladder and the balloon was filled with 7 cc dilute omnipaque. Under Transabdominal Ultrasound guidance, a tandem was placed in the uterus and a vaginal obturator was placed in the vagina. The four corners of the template is sutured to the perineal region for proper immobilization of the needles and after that the needles were carefully inserted through the template under Ultrasound guidance (Figure 1).

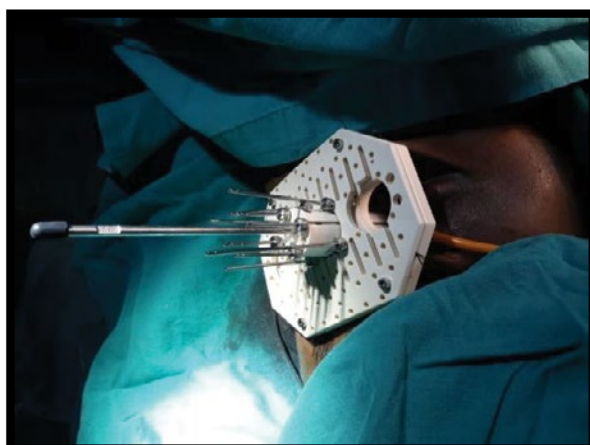


Fig. 1. Image of an Interstitial implant

After the applicator was put the patient was shifted to CT simulator and planning CT was taken after administering contrast into bladder. 1 mm slice thickness planning CT scan was taken. The CT images were imported to Oncentra Treatment Planning System and the Radiation Oncologist meticulously contoured Clinical Target Volume (CTV) and Organ at Risk (OAR). Appropriate dose was prescribed to CTV and Medical physicist. Figure 2 shows axial CT image with interstitial implant, CTV and OARs. Once the plan was generated the plan was approved after carefully noting the CTV coverage and OAR doses from the Dose Volume Histogram (DVH). Various 3D DVH parameters including 0.1 cc, 1 cc, 2 cc doses to the OARs were noted CTV volume, D90 and D100 to CTV also were noted. Once the plan was approved, the same was sent to Nucletron 16 channel HDR Brachytherapy machine and treatment was delivered. The subsequent fraction of HDR Brachytherapy was delivered after a minimum gap of 6 hours.

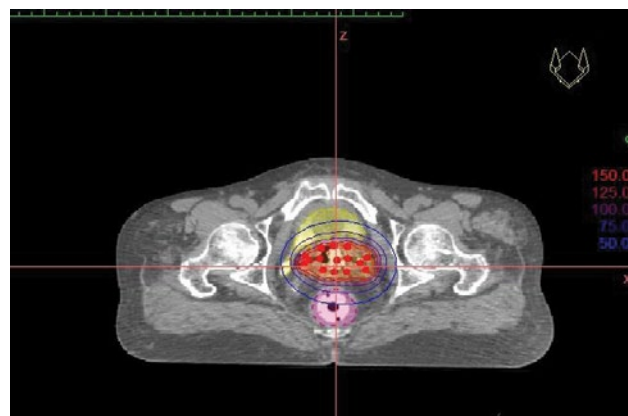


Fig. 2. Axial CT image with interstitial implant

Analysis of Brachytherapy plans from oncentra treatment planning system was done. Demographic data of patients who underwent interstitial Brachytherapy for gynecological malignancies in our institution during the period from 1st Jan 2013 to July 2019 was collected from case sheet. GEC-ESTRO DVH parameters for the doses delivered to 90% and 100% of the CTV ie. D90, D100 were assessed. OAR's (rectum, bladder, sigmoid and small bowel) doses were also noted from the DVH (Figure 3).

Statistics

- Descriptive statistics like Frequencies, Percentages, Median, Mean with standard deviation was used wherever appropriate

RESULTS

Total of 29 Interstitial Brachytherapy (ISBT) details were analysed. Demographic details of the patient who underwent ISBT are shown in (Table 1).

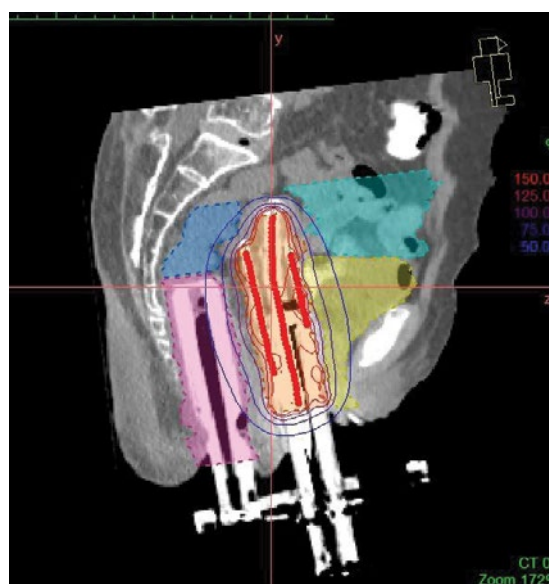


Fig. 3. Sagittal CT image with interstitial implant

Out of the total 29 patients, 25 patients had ISBT alone and rest for patients had both ISBT and ICBT.

External Beam Radiotherapy schedule given was not uniform for all patients. Majority of patients, 14 out of 29, received fractionation schedule of 50.4 Gy in 28 Fractions. Other

Tab. 1. Demographic details of patients who underwent ISBT	Variable	No. of patients
	Age	Median : 58 years (Range : 41-69)
	Primary tumor site	
	Carcinoma Cervix	25 (86%)
	Carcinoma Vagina	4 (13%)
	Histology	
	Squamous cell carcinoma	26 (90%)
	Adenocarcinoma	3 (10%)
	FIGO Stage	
	Carcinoma Cervix	
	III A	5 (17%)
	III B	17 (59%)
	IV B	3 (10%)
	Carcinoma Vagina	
	II	2 (7%)
	III	2 (7%)

fractionation schedules were 55 Gy in 25# in 10 patients, 50 Gy in 25 # in 2 patients, 45 Gy in 25 # in 2 patients and 46 Gy in 23 # in one patient.

In majority of patients, 18 out of 29, Interstitial Brachytherapy (ISBT) schedule was three fractions 7 Gy each. 4 fractions 6 Gy each was given in 3 patients, 3 fractions of 5 Gy each in 3 patients, 4 fractions 6.5 Gy in 2 patients, 4 fractions 5.7 Gy each in 1 patient, 3 fractions of 6 Gy each in 1 patient and 3 fractions 6.35 Gy each in 1 patient.

Mean CTV volume was 133.51 ± 52.83 cc and ranged from 22.27 cc to 235 cc. Since interstitial Brachytherapy fractionation schedule was not same for all patients D90 and D100 are mentioned as percentage of prescribed dose. D100 CTV was 64.88% and D90 CTV was 108.64%. EQD2 dose to CTV combining EBRT dose and D90 dose and assuming an α/β of 10 was 82.77 ± 8.93 Gy. GEC ESTRO Organ at risk (OAR) doses like D2 cc, D1 cc and D0.1 cc to Rectum, Bladder, Sigmoid and Small bowel are shown in (Table 2).

Tab. 2. GEC-ESTRO OAR doses	Organ At Risk (OAR)	Mean ± Standard Deviation (Dose in Gy)
	R 2cc	4.97 ± 1.01
	Rectum R 1cc	5.30 ± 1.07
	R 0.1 cc	6.06 ± 1.34
	B 2 cc	5.64 ± 0.90
	Bladder B 1 cc	6.03 ± 0.97
	B 0.1 cc	7.13 ± 1.31
	S 2 cc	3.74 ± 1.22
	Sigmoid S 1 cc	4.12 ± 1.34
	S 0.1 cc	4.99 ± 1.66
	Bo 2 cc	2.65 ± 0.90
	Small Bowel Bo 1 cc	2.92 ± 1.03
	Bo 0.1 cc	3.57 ± 1.37

Tab. 3. Shows EQD2 Dose to OARs	OAR	Rectum	Bladder	Sigmoid	Small Bowel
	EQD2 Dose (Mean ± Standard deviation) in Gy	75.75 ± 6.54	81.02 ± 6.56	65.22 ± 9.47	58.15 ± 5.09

EQD2 doses to OARs were calculated combining EBRT dose and D2cc dose and assuming α/β of 3. Table 3 shows EQD2 doses to OARs as Mean ± Standard Deviation (SD).

DISCUSSION

Median age of patients who underwent ISBT was 58 years and it was similar to studies by Onoe et al. and Murakami et al [10, 11]. Around 60% of the patients in our study had Ca Cervix FIGO stage IIIB disease, similar to study by Murakami et al. [11] In this study 90% of patients had Squamous cell Carcinoma as histologic type and it was similar to studies by Murakami et al. and Mahantshetty et al. [11, 12].

In majority of patients 25 (86%), who underwent ISBT had Carcinoma Cervix and rest 4 (14%) of the patients had Carcinoma Vagina. Out of the 29 patients, 24 (83%) patients had ISBT alone and 5 (17%) patients had ISBT and ICBT.

Mean CTV was 133.51 cc in our study. In study by Onoe et al. mean CTV was 77.71 cc [10]. In study by Murakami et al. CTV was 137 cc [11]. In our study mean EQD2 dose combining EBRT and D90 of Brachytherapy for CTV was 82.77 Gy and this was slightly higher than in study by Mahantshetty et al. and Sharma et al. [12, 13].

Since ISBT dose was not uniform in all patients, D90 and D100 was assessed as percentage of the prescribed Brachytherapy dose. Mean D90 and D100 were 108% and 65% respectively. Mean D90 was around 113% of prescribed dose in study by Onoe et al. [10].

Our study showed a mean D2 cc to Rectum, Bladder, Sigmoid and Small bowel were 4.97 Gy, 5.64 Gy, 3.74 Gy and 2.64 Gy respectively. Study by Bansal et al. showed mean D2cc to Rectum 4.54 Gy, to bladder 5.93 Gy and to sigmoid 3.35 Gy respectively [14]. Study by Mendez et al. showed mean D2 cc to bladder and rectum 3.71 Gy and 3.85 Gy respectively [15]. Study by Onoe et al. showed a D2 cc to rectum and bladder of 5.43 Gy and 6.25 Gy respectively [10].

EQD2 doses to OARs like rectum, bladder, sigmoid and small bowel combining EBRT and D2 cc Brachytherapy doses assuming a α/β of 3, were 75.75 Gy, 81.02 Gy, 65.22 Gy and 58.15 Gy respectively. EQD2 doses to rectum and bladder in study by Sharma et al were 80 Gy and 76 Gy respectively [13] As per ABS guidelines OAR dose constraints for rectum and bladder are 75 Gy and 90 Gy respectively [7]. Our study have reported acceptable dose to rectum and bladder combining EBRT and ISBT.

CONCLUSION

3D image-based dosimetry with CT based planning using MUPIT implant is a feasible option for gynecological malignancies warranting interstitial brachytherapy.

GEC-ESTRO recommended OAR and CTV parameters helps in plan evaluation and documentation. Our study have shown adequate doses with ISBT to the target region, limiting the doses to OARs to an acceptable level. Hence we recommend routine use interstitial brachytherapy if facilities are available and in clinical situations where ISBT is indicated.

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