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Original Research Article

Interfraction Brachytherapy Application Variability in Cases of Cancer Cervix- A Retrospective Audit

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Abstract:

Introduction: Brachytherapy is an integral part of treatment in cancer cervix. The commonest mode of delivery of radiation by brachytherapy is intracavitary application. This procedure is usually done in two or three settings as per departmental protocol. There can be variabilities in the intracavitary application due to different time schedules where the application may be done by different persons or the planning may be done by different Medical Physicists. This study aims to find out whether there is any variability in different intracavitary applications.

Materials and Methods: The retrospective data regarding intracavitary brachytherapy application was taken out. Nineteen patients were treated between January 2022 to June 2022. All patients had 3 applications and each applications had a prescription of 7Gy to point A. In all the patients, every application was planned by two-dimensional technique by taking orthogonal X-Ray films on C-arm which were transferred to the brachytherapy planning system for planning. The data was retrieved regarding intra uterine length, type of ovoids used, rectal and bladder dose. The data was analyzed for variability.

Results: Out of 19 patients, in 10 patients, application was done by single person (Group I) while as in 9 patients more than 1 person was involved (Group II). Out of 10 patients, in 4 there was change in length of intrauterine tandem and in none there was change in size of ovoids while as out of 9 patients, 6 had change in length of intrauterine tandem and 1 had change in size of ovoids during the 3 applications of brachytherapy. The mean variation in Group I was 0.3cm with a range of -0.5cm to +2cm while as in Group II was 0.4cm with a range of 0cm to +1cm. In 1 patient size of ovoids was changed from half to full after 1st fraction of brachytherapy. Mean rectal dose in Group I was 48.6% with a range of 35.3% to 69% while as in Group II was 44.4% with a range of 28% to 63.3%. Mean bladder dose in Group I was 46.5% with a range of 30.7% to 65.7% while as in Group II was 41.2% with a range of 29.3% to 71.7%.

Conclusion: Inter fraction variability in brachytherapy application was seen which may be attributed to different persons performing the application and doing the brachytherapy plan. To decrease the variability all the 3 fractions should be performed by single Radiation Oncologist and planned by single Medical Physicist.

Keywords: Cervix, Intracavitary brachytherapy, Two-dimensional brachytherapy.

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Introduction

Cervical carcinoma is a common type of cancer in women in India and is a major cause of cancer-related deaths among them. [1,2] For patients in stages IB2 to IVA, the standard treatment involves external beam radiotherapy (EBRT) with simultaneous chemotherapy, followed by intracavitary brachytherapy (ICRT). Brachytherapy is important because it increases the radiation dose to the tumor while protecting nearby healthy tissues and organs like the bladder and rectum [3-8]. To determine the doses for the rectum and bladder during ICRT, reference points from the International Commission on Radiation Unit and Measurement (ICRU) are used [9]. In India, many centres do not have computed tomography (CT) simulator, so orthogonal 2D X-ray imaging-based brachytherapy is done. For ICRT, the dose is prescribed to point A. Point A as recommended by Manchester system was originally defined as 2 cm superior to the lateral vaginal fornix and 2 cm lateral to the cervical canal. [10] Isodose distributions are seen in the frontal and sagittal planes (standard pear-shaped isodose lines) in addition to obtaining dose at point A and at the same time dose to OAR such as bladder and

rectum. This technique is commonly known as conventional brachytherapy. [11]

The most frequent clinical complications of the treatments result from a high dose delivered to rectum and bladder that are near the irradiation area. Applicator placement in intracavitary brachytherapy is very important to keep the dose received by these critical organs as low as possible. Bladder and rectum point doses can be estimated using recommendation by ICRU report No. 38 (1985)9 reference points for 2D planning. The simplicity and cost-effectiveness of radiograph-based 2D planning has ensured its continued applicability for dose reporting in brachytherapy [12]. The insertion of the applicator relies on the doctor's proficiency and familiarity with the procedure. Poor packing may result in an increased dose to specific organs and poses a challenge for the oncologist to properly place the applicator with suitable packing for every insertion in each individual patient.

There can be variabilities in the intracavitary application due to different time schedules where the application may be done by different persons or the planning may be done by different Medical Physicists. This study aims to find out whether there is any variability in different intracavitary applications.

Materials and Methods

The retrospective data regarding intracavitary brachytherapy application was taken out. Nineteen patients from our institute who were diagnosed and treated with definitive chemo radiation therapy for carcinoma cervix from January 2022 to June 2022 were included in the study. Patients with biopsy proven carcinoma cervix were included in the study. Staging was done by the 2018 FIGO staging system.[14]

All patients were planned to receive EBRT of 50 Gy in 25 fractions at 2 Gy per fraction and three fractions of ICRT after completion of EBRT by Ir-192 HDR remote after loading technique using Fletcher suit applicator. All the study patients were treated with three fractions of HDR brachytherapy to a total dose of 21 Gy in three fractions, 7 Gy per fraction to point A, with 1-week gap between the fractions.

Patients were divided into two groups: Group I had 10 patients which were performed and planned by single Radiation Oncologist and Medical Physicist while as Group II had 9 patients and more than 1 Radiation Oncologist and Medical Physicist were involved in different fractions during Brachytherapy.

Procedure of Intracavitary Brachytherapy: Treatment was performed on an outpatient basis. The patient should was informed about the procedure before ICRT, and informed consent was obtained. A detailed gynaecological exam was performed, and the dimensions of the vagina, the size and position of the uterus, and the localization, size and extension of the tumor were determined. Procedure was done under systemic analgesia with sedation as cervical dilatation is required.

The patient is positioned in the lithotomy position on a gynaecological table. The vulva, perineum, and pelvic region are cleaned and a Foley catheter was placed into the bladder. Its balloon was filled with 7 cc of radiopaque material diluted in normal saline. Then, it was pulled down to be seated on the bladder trigone. A speculum was placed into the vagina, and the cervical os was visualized. The cervical canal was dilated with Hegar dilator of different thicknesses. The length of the uterine cavity was determined by inserting the uterine sound and then measuring the blood stain on it with a sterile measuring scale. An applicator is a rigid device and made of stainless steel. It is inserted into the patients' vaginal and uterine cavities. The applicator set consists of combination of a pair of ovoid and a tandem. The size of ovoid and the length of tandem applied for ICRT are the major factors that affect the dose to the organ at risks. The size of ovoid represents the diameter of the ovoid and the dose is more uniform as the diameter of the ovoid increases. The tandem and ovoids were lubricated with 1% viscous lidocaine. The tandem was first placed into the uterine cavity, and then the ovoids or ring were placed into the fornices and they were all stabilized. The angle between the longitudinal axis of the tandem and the diameter of the ring is always 90.

The vaginal packing was done using sterile gauze soaked in a contrast material for defining the ICRU 38 rectal point, which is located 0.5 cm posterior to the posterior vaginal wall. A rectal tube was placed for all patients for calculating the rectal dose as an institute protocol. When using the rectal tube, we calculated the rectal dose using the modified ICRU rectal point, which is along the same line as the ICRU 38 rectal point but extended posteriorly onto the rectal wire. The orthogonal images used for planning are shown in Figures 1 and 2. Packing procedure was conducted during insertion of applicators to avoid any shifts or changes in the geometry of the applicators position and at the same time prevent the relocation of rectum and bladder. Dummy catheters are placed into the tandem and ring/or ovoids for dose calculations in orthogonal films. For simulation procedures, x-ray markers or dummies were inserted through the applicator's cavity. The markers are function to visualize the image of each applicator on the radiographs and source loading positions in treatment planning. Anterior-posterior (AP) and lateral view (orthogonal radiographs) of the patients were taken (Figure 1). The radiographs

taken should clearly visualize the bonny structures of pelvic region, dummies inside each applicator and OAR markers.

The dose is prescribed to point A. The dose distribution should be pear-shaped when the tandem is used (Figure 2). Its large side is located in the upper vagina, and its narrow edge is in the uterine fundus. The source, place and time are optimized in dosimetry; the plan that enables the maximum dose to be delivered to the target and the minimum dose to the bladder and rectum is selected, and the patient is taken to the treatment room. Applicators are connected to the treatment machine with special connecting cables.

Health personnel move from the treatment room to the command room and start the BT session. One session takes between 5 and 15 min, depending on the source activity in that session of HDR BT. After the treatment has finished, the applicators are taken out. The same procedure is repeated during each session.

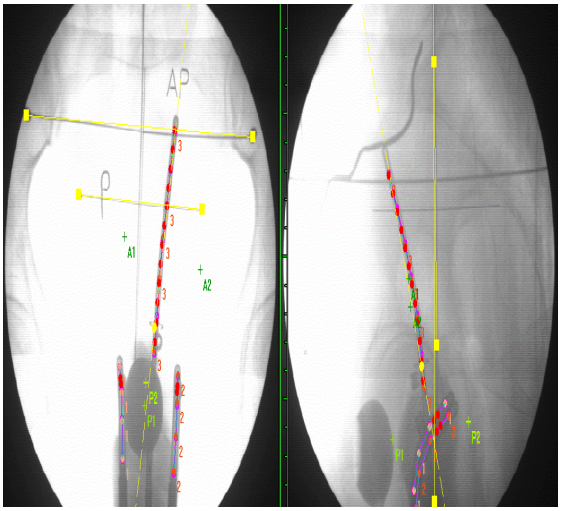

Figure 1: Anterior-posterior (AP) and lateral view (orthogonal radiographs) of the patient

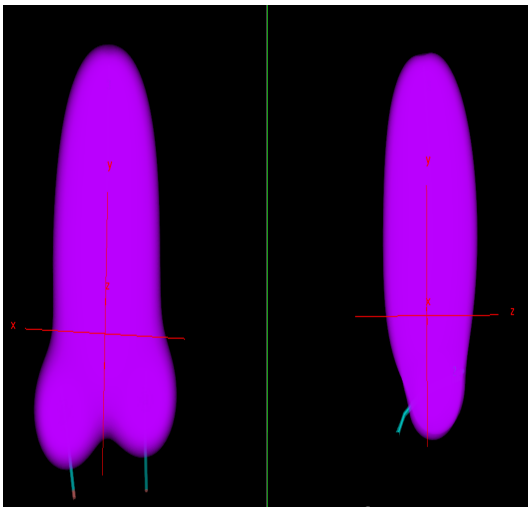

Figure 2: Pear shape can be seen in Anterior-posterior (AP) view and lateral view of dose wash

The data was retrieved regarding intra uterine length, type of ovoids used, rectal and bladder dose in each brachytherapy session. The data was analyzed for variability in terms of mean displacement, use of ovoids and to see the doses of OARs.

Results

Table 1: Intrauterine length for each fraction in both groups

Group	Patients	Length			Mean	Displacement	Mean Displacement
		1st frc	2nd frc	3rd frc			
Group I	Patient 1	4	4.5	4.5	4.3	0.5	0.3
	Patient 2	5	5	5	5.0	0.0	
	Patient 3	4	4	4	4.0	0.0	
	Patient 4	5	5	5	5.0	0.0	
	Patient 5	5	5	4	4.7	-1.0	
	Patient 6	5.5	5	5	5.2	-0.5	
	Patient 7	5	6	6	5.7	1.0	
	Patient 8	5	6	7	6.0	2.0	
	Patient 9	6	6	6	6.0	0.0	
	Patient 10	4	4	4.5	4.2	0.5	
Group II	Patient 1	6	5	6	5.7	0.0	0.4
	Patient 2	4.7	5	5	4.9	0.3	
	Patient 3	5	5	5	5.0	0.0	
	Patient 4	5	5.5	5.5	5.3	0.5	
	Patient 5	5	5.5	5	5.2	0.0	
	Patient 6	5	5	5	5.0	0.0	
	Patient 7	4	5	5	4.7	1.0	
	Patient 8	5	5	5	5.0	1.0	
	Patient 9	4	4	5	4.3	1.0	

Table 2: Rectal dose for each fraction in both groups

Group	Patients	1st frc	2nd frc	3rd frc	Mean
Group I	Patient 1	65	54	44	54.3
	Patient 2	41	65	64	56.7
	Patient 3	40	76	24	46.7
	Patient 4	60	34	45	46.3
	Patient 5	80	56	71	69.0
	Patient 6	62	56	50	56.0
	Patient 7	30	36	44	36.7
	Patient 8	30	57	51	46.0
	Patient 9	32	34	40	35.3
	Patient 10	49	30	38	39.0
Group II	Patient 1	24	46	32	34.0
	Patient 2	45	32	69	48.7
	Patient 3	50	43	46	46.3
	Patient 4	31	36	61	42.7
	Patient 5	58	48	63	56.3
	Patient 6	65	65	60	63.3
	Patient 7	50	54	44	49.3
	Patient 8	28	30	34	30.7
	Patient 9	17	50	17	28.0

Table 3: Bladder dose for each fraction in both groups

Group	Patients	1st frc	2nd frc	3rd frc	Mean
Group I	Patient 1	32	34	34	32
	Patient 2	41	38	43	41
	Patient 3	20	22	50	20
	Patient 4	45	15	71	45
	Patient 5	52	83	62	52
	Patient 6	52	52	57	52
	Patient 7	70	60	55	70
	Patient 8	40	40	56	40
	Patient 9	30	32	30	30
	Patient 10	71	69	39	71
Group II	Patient 1	32	32	59	32
	Patient 2	89	63	63	89
	Patient 3	25	35	36	25
	Patient 4	37	46	21	37
	Patient 5	28	44	44	28
	Patient 6	34	30	40	34
	Patient 7	27	28	38	27
	Patient 8	70	50	54	70
	Patient 9	39	29	20	39

Table 4: Summary for each fraction in both groups

Groups	1st fraction			2nd fraction			3rd fraction		
	Length	Rectal Dose	Bladder Dose	Length	Rectal Dose	Bladder Dose	Length	Rectal Dose	Bladder Dose
Group I	4.9	48.9	45.3	5.1	49.8	44.5	5.1	47.1	49.7
Group II	4.9	40.9	42.3	5.0	44.9	39.7	5.2	47.3	41.7

Table 5: Mean dose at Point A (Right and Left) in both groups

Group	Patients	Point A Dose R	Point A Dose L
Group I	Patient 1	99.8	100.2
	Patient 2	100	100
	Patient 3	100.2	100.1
	Patient 4	99.9	99.8
	Patient 5	100.4	100.3
	Patient 6	99.9	100.1
	Patient 7	100	100
	Patient 8	99.9	99.8
	Patient 9	100.4	100.3
	Patient 10	100	99.8
Group II	Patient 1	99.7	100
	Patient 2	100.4	100.6
	Patient 3	100.2	99.9
	Patient 4	100	100
	Patient 5	99.8	100.2
	Patient 6	99.6	100.2
	Patient 7	100	100.2
	Patient 8	100.2	100.4
	Patient 9	99.9	100.1

Discussion

The American Brachytherapy Society (ABS) strongly recommends that radiation treatment for cervical cancer should include brachytherapy as a component of treatment14. In our study also all the patients received Brachytherapy which was preceded by EBRT.

With advancements of techniques in Brachytherapy specially Image Guided have led to more precision delivery to the local site. These new advanced techniques are still not available in most of the centres in developing countries. Conventional Xray based brachytherapy planning is till the commonest used in most of the centres. To deliver precision radiotherapy in such cases is challenge. The present study is done to see whether variations in interfraction brachytherapy applications are seen and could be reduced to deliver better radiotherapy in limited resources.

Abdullah R et al [15] in a Malaysian study of 21 patients concluded that combinations of ovoid's size, length of tandem and anatomy variation between each patient were factors that affected the dose to the OAR. Therefore, the ICRU reference points can still be used with the 2D brachytherapy treatment planning in evaluating the OAR doses. They used ovoid sizes about 1.5cm which resulted higher 80% and 60% doses to rectum and bladder for which they concluded that ovoid with smaller size is unable to filter scattered photon and gives higher doses to OARs. The length of tandem ranged from 3 to 6cm which was decided by the doctor based on disease extent and stage and they found that when tandem length was ≤5cm then 80% and 60% doses to OARs were more since shorter tandem tend to increase the doses of OARs.

In our study 2 patients of Group I had ovoid size 2cm, rest all had 2.5cm while as in Group II one patient had ovoid size 2cm and one had ovoid size 1.5cm. In Group I mean dose to rectum and bladder was 69%, 39% and 65.7%, 59.7% respectively. Both in Group I and Group II, six patients had mean tandem length ≤5cm and only 1 patient in each group had rectal and bladder doses above 60% (Table 2 and 3). With these findings we can infer that the variations in ovoids and tandem lengths (Figure 3)are attributed to the different Radiation Oncologists doing the application and further leading to different variable doses to OARs. Further, in the cases where there is less variation in applications we still find difference in doses planned which is due to the different Medical Physicist planning the cases.

In a retrospective study of 38 patients by Sharma BA et al16, they found that 85% patients received rectal and bladder doses below 80% of prescribed dose at point A. In our study all the patients received less than 80% dose to rectum and bladder. This variation can be attributed to the different skills acquired by the Radiation Oncologist and different planning strategies of Medical Physicists.

Rectal and bladder doses in ICRT for cervical cancer are estimated using the International Commission on Radiation Unit and Measurement (ICRU) reference points [9]. Institutions also observed to practice rectal and bladder dose keeping below 80% of dose at point A for each fraction17 in the similar line as recommended by ABS [14]. Our study also correlates with the results with bladder dose less than 80% in both the groups despite intrauterine length variability (Table 4).

Patient's movements also greatly affect the variation doses to bladder and rectum. Not only the movements happened during the insertion procedures in the operation theater, but it could also happen while the patient was transferred to the couch for simulation procedures. Patient's movements in any intracavitary brachytherapy procedure can displace the applicators, especially the tandem. Anterior shifts are correlated with high bladder dose differences. Immobilization of the patient's hips and legs, as well as stabilization of applicators, would reduce these shifts [18]. The movements of the patients can be reduced by general anesthesia/ spinal anesthesia rather than conscious sedation which will relax the local anatomy and better patient compliance. This will further lead to better stabilization of applicators and reducing the errors.

After intracavitary application there is lot of space in the vaginal cavity which needs to be filled up with gauze packs so that the applicators do not move. A gauze pack serves two purposes; it pushes the rectum and bladder away from the applicator and produces enough immobilization to the applicator in situ. Gauze packing is one of the factors affecting the dose to rectum and bladder [19]. As all procedures were performed under conscious sedation, sufficient packing was difficult, as well as the patient's movement during the procedures. To make an optimum gauze packing we recommend to so the procedures under short general anesthesia/ spinal anesthesia. The study has limitation of not evaluating the lymphatic trapezoid as per ICRU 389. It has clinical significance in evaluating doses to other lymphatic areas besides the various Point A, Point B, Rectal and Bladder point.

The insertion of an applicator depends on the doctor's skills and experiences in handling the procedures. Inadequate packing may cause less dose to Point A (Table 5) or higher dose to OAR and it challenges the oncologist to place the applicator with adequate packing for each insertion and each individual patient (Figure 4). Similarly the planning by Medical physicist also depend upon the his experience. The variations seen in the present study in terms of application of brachytherapy and doses to rectum and bladder is mainly due to different personnel doing their respective responsibilities. To decrease the inter fraction brachytherapy application variation we recommend that the same Radiation and Oncologist and Medical Physicist should do the application and planning for all the three fractions in the same patient.

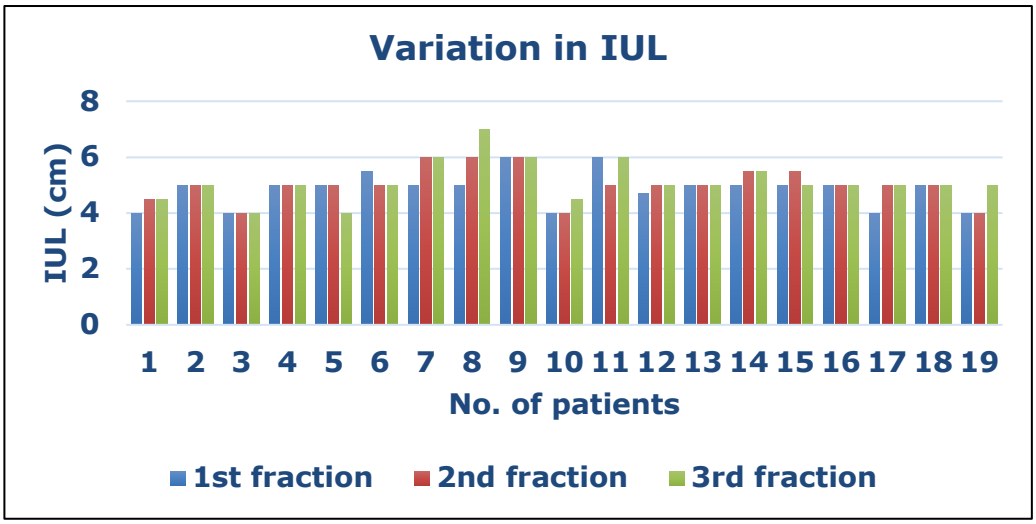

Figure 3: Variation in Intrauterine length for each fraction in all patients

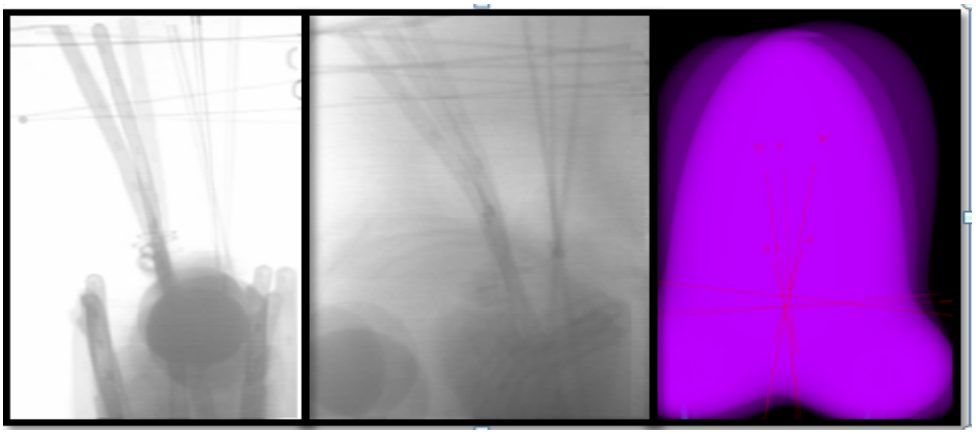

Figure 4: Fusion showing variation of three 7 Gy tandem position in AP and Lateral view along with Pear shape in a single patient

Conclusion

Inter fraction variability in brachytherapy application was seen which may be attributed to different persons performing the application and doing the brachytherapy plan.

To decrease the variability all the 3 fractions should be performed by single Radiation Oncologist and planned by single Medical Physicist.

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