

Comparison of ICRU and GEC-ESTRO Organ at Risk Doses in Intracavitary Brachytherapy for Carcinoma Cervix

Vinin NV, Joneetha Jones*, Shimjith Narayanan, Resmi K Bharathan, Nabeel Yahiya EK, Arun P Narendran, Greeshma KE, Shoaib Nawaz PN and Geetha Muttath

Department of Radiation Oncology, Malabar Cancer Centre, Kerala, India

*Corresponding author: Joneetha Jones, Assistant Professor, Department of Radiation Oncology, Malabar Cancer Centre, Kerala, India, E-mail: Joneetha14@gmail.com

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Abstract

Background: In Intracavitary Brachytherapy (ICBT) for cervical cancer doses to bladder and rectum were traditionally estimated using the International Commission on Radiation Units and Measurements (ICRU) reference points and in recent years, volumetric assessment of Organ At Risk (OAR) doses is being done. This study aim to know any concordance between ICRU and GEC-ESTRO recommended OAR doses.

Materials and methods: This was a retrospective study. ICBT done in Carcinoma Cervix patients with a dosage schedule 7 Gy for 3 fractions during the period January 2017 to December 2017 were analysed. CT based ICBT plan was analysed from Treatment Planning System. From the DVH parameters OAR doses like D 0.1 cc, D1 cc and D2 cc was noted. ICRU rectal point and bladder point doses were noted from corresponding CT images. Point A doses on right and left side and EQD2 doses to point A and OAR were calculated.

Results: 165 ICBT details were analysed. Mean ICRU rectal and bladder point doses were 4.43 Gy and 3.83 Gy respectively. D2 cc dose to Rectum, Bladder and Sigmoid was 3.51 Gy, 5.23 Gy and 4.72 Gy respectively. Mean Point A dose on right and left side were 6.87 Gy and 6.91 Gy respectively and EQD2 dose to point A on right and left side were 78.5 Gy and 78.8 Gy respectively. Mean OAR doses combining EBRT and ICBT with ICRU point doses for Rectum and Bladder was 68.1 Gy and 64.1 Gy respectively and OAR doses combining EBRT and ICBT with GEC ESTRO D2 cc doses for Rectum, Bladder and Sigmoid were 62.1 Gy, 74.2 Gy and 70.2 Gy respectively.

Conclusion: Study showed no concordance between ICRU rectal and bladder point doses to GEC-ESTRO recommended OAR doses. We recommend a CT based ICBT planning with documentation of GEC-ESTRO recommended OAR doses for proper documentation of OAR doses.

Introduction

Annual incidence of Carcinoma Cervix worldwide is 569,847 [1]. In the management of Carcinoma Cervix Intracavitary Brachytherapy (ICBT) is an integral part. With ICBT it is possible to achieve good therapeutic index and deliver high dose to tumor region sparing adjacent Organ At Risk (OAR) [2]. A Rectal and Bladder dose from Intracavitary Brachytherapy was traditionally estimated using the International Commission on Radiation Units and Measurements (ICRU) reference points [3].

With advances in three dimensional planning in ICBT, doses to OARs like bladder, rectum and sigmoid can be quantified using dose volume histograms. GEC-ESTRO has published recommendations for dose reporting for three dimensional image based brachytherapy [4,5]. Combining External beam radiotherapy and brachytherapy the acceptable iso-equivalent dose limits to the bladder and the rectum are 90 and 75 Gy, respectively.

ICRU point-based dose reporting to the OARs in ICBT is widely practiced but it has the inherent weakness in predicting the late toxicities [6,7]. Proper documentation of absorbed dose heterogeneity in the organ walls is not possible with point based dose reporting. Because of this it would be better to report the dose-volume values in

the high-dose region. Volumes of OARs that receive the maximum dose are represented by D0.1 cc, D1 cc, and D2 cc, respectively.

The differences between volumetric doses and point based doses to the bladder and the rectum have been reported earlier in several studies [8-10]. The best correlation was found between the D2 cc dose and ICRU point doses [11-13]. With this present study we want to compare ICRU point doses with GEC-ESTRO volumetric OAR doses.

Methodology

This was a retrospective study done in Department of Radiation Oncology in a Tertiary Cancer Centre in Kerala, India. All Carcinoma cervix patients who underwent ICBT, with CT based planning with a dose fractionation of 7 Gy with 3 fractions during the period January 2017 to December 2017 was included in the study. Patients who received other dose fractionation were excluded from the study. All patients in the study received an EBRT dose of 50.4 Gy in 28 fractions.

Total of 55 patient details that is 165 ICBT details were analysed. CT based ICBT plan was analysed from Oncentra Treatment Planning System (TPS). Point A dose to Right and Left side was noted from TPS. From the DVH parameters OAR doses like D 0.1 cc, D1 cc and D2 cc was noted. The rectal point was placed on the anterior rectal wall at the level of the lower uterine source on the tandem, on an anteroposterior

line drawn through the tandem on the sagittal view. The ICRU bladder point was placed on an anteroposterior line drawn through the center of the Foley balloon at the posterior surface of the balloon on the sagittal view and corresponding live dose was measured from Treatment Planning System. EQD2 doses combining EBRT dose and ICBT dose to point A and OARs was computed from Treatment Planning System.

Statistical analysis

Descriptive statistics was used wherever appropriate. t-test was used as to compare means of ICRU point doses with GEC-ESTRO D2 cc doses.

Results

55 patients' details were analysed. Each patient had three ICBT sessions, hence a total of 165 ICBT details were analysed. Demographic details are given in Table 1.

Variable	Median/No. of patients
Age	Median: 57 years
FIGO Stage	
Stage IB1	5 (9%)
Stage IB2	10 (18%)
Stage IIB	28 (51%)
Stage IIIB	12 (22%)
Histology	
Squamous cell carcinoma	52 (95%)
Adenocarcinoma	03 (5%)

Table 1: Showing demographic details of patients in the study.

Point A dose (mean dose and EQD2 dose combining EBRT and ICBT) are shown in Table 2. EQD2 dose to Point A was calculated combining EBRT and ICBT dose and assuming α/β of 10 for tumor tissue.

Point A dose	Mean dose	EQD2 dose
Right Point A	6.87 Gy	78.5 Gy
Left point A	6.91 Gy	78.8 Gy

Table 2: Showing Point A dose.

Comparison of ICRU Rectal and Bladder doses with GEC-ESTRO D2 cc to Rectum and Bladder is shown in Table 3. ICRU rectal point dose was 1.26 times higher compared to GEC-ESTRO D2 cc dose. ICRU bladder point dose was 1.37 times lesser compared to GEC-ESTRO D2 cc dose. D1 cc dose to Rectum and Bladder was 3.96 Gy and 5.86 Gy respectively. D 0.1 cc dose to Rectum and Bladder was 5.08 Gy and 7.36 Gy respectively.

EQD2 dose to combining EBRT and ICBT dose assuming α/β of 3 with ICRU point dose for rectum and bladder was 68.1 Gy and 64.1 Gy

respectively. Using GEC-ESTRO D2 cc dose, the EQD2 dose to rectum, sigmoid and bladder was 62.1 Gy, 70.2 Gy and 74.2 Gy respectively.

OAR	ICRU point dose	GEC-ESTRO D2 cc dose	p-value
Rectum	4.43 Gy	3.51 Gy	<0.0001
Bladder	3.81 Gy	5.23 Gy	<0.0001

Table 3: Showing OAR doses and comparison.

Discussion

In ICBT for Carcinoma Cervix, the OAR (rectum and bladder) doses are a major concern. Proper documentation of OAR doses is possible with the advent of three dimensional image based brachytherapy. In most of the institutions still ICRU point based reporting is followed. Recently many institutions have moved towards three dimensional image based brachytherapy and reporting of volume based bladder and rectum doses. Various studies have compared volume based D2 cc doses with corresponding ICRU point based doses. These studies have shown that ICRU point based bladder dose was underestimated compared to D2 cc dose [14-16]. Our study also showed similar result and D2 cc dose was 1.37 times greater than the ICRU bladder point dose. In a study by Jamema et al. they reported 1.56 times D2 cc dose compared to ICRU bladder point dose [17].

With regards to rectal dose, some studies have reported higher D2 cc dose compared to rectal ICRU point dose [18,19]. In contrast to these studies, our study has shown that ICRU rectal point dose was 1.26 times greater than D2 cc rectal dose.

The EQD2 dose to point A on right side was 78.5 Gy, and on left side was 78.8 Gy. EQD2 doses to bladder combining EBRT and ICBT dose was 64.1 Gy with ICRU point dose and 74.2 Gy with D2 cc dose respectively. EQD2 doses to rectum were 68.1 Gy with ICRU point dose and 62.1 Gy with volume based dose. Kirisits et al. also reported similar rectal doses, 64 Gy with D2 cc dose and 69 Gy with ICRU point dose respectively in their study [20].

In our study mean comparison was done between rectal and bladder ICRU point doses with D2 cc doses to rectum and bladder. There was statistically significant (p-value<0.0001) difference between ICRU and GEC-ESTRO doses.

Conclusion

This study showed no concordance between ICRU rectal and bladder point doses to GEC-ESTRO recommended OAR doses. ICRU rectal point dose was lesser than the D2 cc rectal dose. But ICRU bladder point was higher than D2 cc bladder dose. Hence we recommend wherever feasible for a CT based ICBT planning with documentation of GEC-ESTRO recommended OAR doses for proper documentation of OAR doses.

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