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Intensity-Modulated Radiotherapy And Three-Dimensional Conformal Radiation In Prostate Cancer Treatment: A Dosimetric Study

Manjeet Kumar [1], Sunita Dahiya [2], Parveen Bhatt [3], Sandeep Yadav[4]
[1]RS - Deptt of Physics Baba Mastnath University, Asthal Bohar ROHTAK -124021
[2&3]Professor, Deptt of Physics Baba Mastnath University, Asthal Bohar ROHTAK -124021
[4]Assistant Professor, CCS Haryana Agriculture University, Agriculture College, Bawal Rewari - 123401

ABSTRACT
There is just a small amount of research that compares dosimetry parameters in depth. There are two alternative strategies for prostate cancer treatment: three dimensional conformal radiation (3D CRT) and intensity modulated radiotherapy (IMRT). Ten prostate cancer patients' computed tomography planning data were used in an experimental research with intervention. The goal volume was planned with an 80 Gy dosage in 40 segments. Between 3DCRT and the other abovementioned procedures, the mean V75 Gy rectum and bladder revealed significant differences (P 0.05). There is a statistically significant difference in V5 Gy remaining volume at risk (RVR) between 3DCRT and IMRTSS (P 0.0001). The V75 Gy rectum bladder between 3DCRT techniques differs greatly from the other techniques and may not be suited for escalation dosage application. The HT approach provided the highest V5 Gy RVR and required the most monitor units and radiation time. The IMRT approach was thought to be capable of achieving dose escalation in prostate cancer radiotherapy while reducing rectum and bladder damage with the lowest radiation time.
Keywords: **Intensity-modulated radiotherapy, prostate cancer, three-dimensional conformal radiotherapy**.

INTRODUCTION

Surgery, hormone treatment, and radiation are all options for treating prostate cancer right now. In the treatment of prostate cancer, radiotherapy (in the form of external radiation and brachytherapy) is very significant.[1] Three dimensional conformal radiotherapy (3D CRT), intensity modulated radiotherapy (IMRT) in the form of IMRT static (step and shoot [SS]), and dynamic IMRT are all external radiation treatments that can be employed for prostate cancer (sliding window).[2,3]
Recent research has revealed that escalation doses of more than 75 Gy can enhance control and minimise recurrence rates in instances of prostate cancer, but can potentially increase morbidity.[4,5] Many studies have examined the quality of dosimetry amongst current radiation modalities in cases of prostate cancer as a result of this. Radiation can induce short- and long-term morbidity in organs at risk (OAR), such as the rectum and bladder in this example. [7] When PSA testing was used to evaluate therapy results, the usefulness of 2D approaches was called into doubt. [7,8] Escalating the dosage improves biochemical control, but it comes at the cost of increased radiation-related morbidity and dose exposure to OAR. [4] Radiation-induced morbidity and OAR dosage exposure .[4] In radiation for prostate cancer, the dosages are being increased. Up to 75 Gy was believed to be able to enhance relapse-free survival.[6,9] Which said that increasing the total dosage from 70 Gy to 80 Gy will improve the 6-year independence from failure in moderate and high-risk prostate cancer patients from 45 percent to 60 percent. Patients with low risk should get doses of 75-80 Gy with conventional fractions, whereas patients with medium or high risk should receive doses of 75-80 Gy with

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conventional fractions. This was an exploratory experimental study in which researchers intervened on computed tomography (CT) plan data of prostate cancer patients who were receiving radiation. The goal of this research is to figure out how 3D CRT and IMRTSS radiation methods vary in dosimetry characteristics. High-risk prostate cancer CT plan is one of the inclusion criteria.

MATERIALS AND METHODS

Prostate cancer CT plan after radical prostatectomy, with involvement of regional lymph nodes, and recurring prostate cancer are among the exclusion criteria. Data from the CT plan database backup was used to compile the CT plan. The images were created on a 2.5 mm thick GE Bright Speed CT simulator from GE Health Care. The rectum, bladder, penis bulb, and femoral head were all delineated for OAR. In this study, the residual volume at risk (RVR) was defined as the complete body volume of patients within 1 cm of the cranial and caudal directions of planning target volume (PTV), excluding clinical target volume (CTV) and OAR. A radiation oncologist checked the findings of the delineation. TPS Eclipse External Beam Planning System was used to create planning procedures for 3D CRT and IMRT. Data demarcation was uploaded to TPS accuray planning station for HT methods, and planning was done there.

On a Linac accelerator with 6 MV of energy beams fractions, the dosage prescription was 80 Gy in 40 fractions. The minimal dose received 95 percent of the PTV volume was 95 percent of the recommended dose (D95 percent 95 percent dose prescription) was one of the limiting factors employed in this investigation. The greatest dosage received by 2% of the PTV volume was 105 percent of the recommended dose (D2 percent dose prescription). A dosage of 75 Gy was given to no more than 15% of the rectal volume. To reach the criteria above, as much planning as feasible must be done. If the parameter limitations for the OAR, either rectum or bladder, cannot be satisfied, the priority will be to meet the parameter limits for the OAR. Coplanar directions (0° to 360°) on axial pieces and MLC120 millennium variations are used in the 3D CRT radiation technology.[14] On axial pieces and MLC120 millennium versions, the IMRTSS radiation technology uses 5 coplanar directions (0°, 360°). [14] The couch is at a 0° angle. The gantry begins at an angle of 181 degrees and ends at an angle of 179 degrees. [15] The Eclipse TPS External Beam Planning System determines the field size and collimator angle automatically in order to cover PTV as efficiently as feasible. Anisotropic Analytical Algorithm with 2.5 mm spatial resolution was employed in all three ways to calculate dose. The printed dose volume histogram (DVH) or the TPS are both good sources of data for dosimetry parameters. Conformity index (CI), homogeneity index (HI), monitor unit (MU), length of irradiation, D98 percent PTV, D95 percent PTV, D2 percent PTV, and D50 percent PTV, V75 Gy for rectum and bladder, and V5 Gy for RVR are among the parameters examined in this study. The research variables were analysed using the paired ttest or Wilcoxon test.

RESULTS

This study included CT plan data from a total of ten individuals. Table 1 shows the results.

Table 1: Individuals' characteristics

SrNo	Age (years)	PTV (cm3)	SrNo	Age (years)	PTV (cm3)
1	71	354	6	63	255
2	72	718	7	64	348
3	65	474	8	74	305
4	53	634	9	65	251

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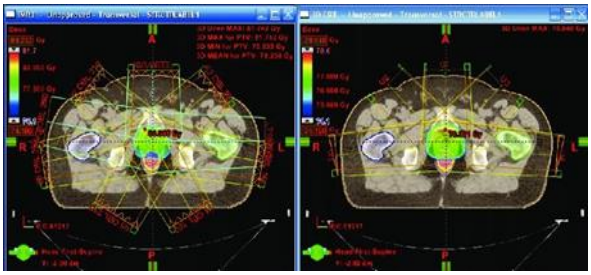
5	62	277	10	71	334

Mean ±SD66±6395±162 Minimum-maximum53-74 251-718 SD=Standard deviation, PTV=Planning target volume



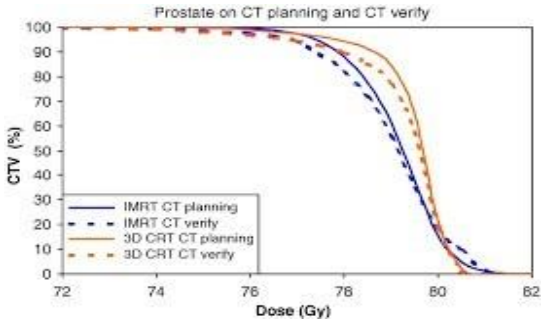


Figure 1 3D-CRT and IMRT computed tomography (ct scan)
Figure 2 DVH planning of two techniques (3D-CRT and IMRT)

In figure 1 computed tomography (CT scan) of two techniques 3D-CRT and IMRT gives comparative results. Figure 2 shows the DVH planning results between the two techniques in one sample, illustrating the PTV and OAR curves. Figure 2 shows the dosimetry average of D2 percent, D50 percent, D95 percent, and D98 percent planning target volume between three dimensional technique and intensity modulated radiotherapy step and shoot. The two methodologies were able to satisfy the restrictions of the PTV parameters employed in the study, although there were disparities in their capacity to achieve the limits of the dosage parameters for OAR, as shown in Figure2.
Table 2 comparison parameters between planning target volume (PTV) D2%, D50%, D95%, D98%
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Parameters	3D-CRT	IMRT	3D-CRT VSIMRT	Parameters	3D-CRT	IMRT	3D-CRT VSIMRT
D2%	103	105	0.007	D98%	94	94	0.798
D50%	100	100	0.234	V75Gy Rectu	61	13	<0.0001
D95%	95	95	0.238	V75Gy Bladd	50	20	0.012

Table 2 displays the results of the mean comparative parameters analysis for D2%, D50%, D95%, and D98%. The D2 percent value in the 3DCRT and IMRT procedures was statistically significant (P 0.05) when compared to the other two techniques in the table. Table 2 reveals that only significant differences between the IMRT and 3D-CRT techniques were discovered in the comparison study of D50 Parameters 3D-CRT IMRT 3D-CRT VS IMRT D2% 103 105 0.007 D50% 100 100 0.234 D95% 95 95 0.238 D98% 94 94 0.798 V75Gy Rectum 61 13 <0.0001 V75Gy Bladder 50 20 0.012 percent values. Furthermore, no significant differences were found between D95 percent mean in 3DCRT methods and IMRTSS.

DISCUSSION

This study found that the four radiation methods utilised produce a satisfactory and clinically acceptable absorbed dose distribution (to meet the planning requirements). On PTV, the mean values of D95 percent, D2 percent, and D50 percent demonstrate this. D95 percent 95% dosage prescribed, D50 percent >100% dose prescribed, and D2 percent 107 percent dose prescribed characteristics were employed in this investigation. [16] Between three dimensional conformal radiation, intensity modulated radiotherapy, and step and shoot procedures, there is a difference in the volume of the

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rectum and bladder that got doses of 80 Gy (V80 Gy) and the volume of the remaining volume at risk that received doses of 7 Gy (V7 Gy).

This is in line with Uysal network, .'s which examined dosimetry parameters between IMRT and 3DCRT using V60 Gy rectum and V60 Gy bladder. [1] This problem is produced by the greater number of segments that may be exposed in the IMRT technique as compared to 3DCRT procedures, which expose fewer essential organs, particularly the rectum and bladder. Other newer approaches, such as IMRTSS, can fulfil the necessary dosage limitations for the rectum and bladder while still giving a decent dose distribution to the PTV with no notable deviations, unlike 3D CRT [Table 2]. This finding is consistent with the findings of Pasquier et al. and Davidson et al.

However, the difference was not substantial; hence, IMRT approaches were able to produce outcomes that were almost identical in sparing dosages. [17,18] According to Leszczyski et al., both 3D-CRT and IMRT offer high conformance dose distribution capabilities with OAR sparing. [19] V5 Gy RVR was also evaluated in this investigation to estimate lowdose radiation exposure in normal tissue in the radiation field. [18] The scatter dose, MU value, and normal tissue volume receiving low dose radiation are all known to impact the risk of radiation-induced malignancy. It is well known that the use of 3D-CRT and IMRT imaging raises the risk of subsequent malignancy by 1.0 and 2.8 percent, respectively.

CONCLUSION

The difference between D2 percent PTV 3DCRT and IMRT technology is shown to be substantial in this study. (IMRT-SS). Between 3D-CRT and IMRTSS, significant differences were found between D50 percent and PTV D98 percent. Overall, the four approaches were able to generate a fair dose distribution and were clinically recognised to fulfill the planning requirements. In comparison to IMRT, the V75 Gy rectum (61.22 18.80) and bladder between 3DCRT approaches (50.17 29.32) differ substantially. Because of the rise in V80 Gy, 3D-CRT approaches may not be acceptable for prostate cancer dose escalation due to increased toxicity concerns.

The capacity to use sparing dosages on vital organs, as well as the capability. The IMRT approach was thought to be capable of achieving dose escalation in prostate cancer radiation while reducing rectum and bladder damage. When compared to 3D-CRT approaches, the shortest radiation time employing the IMRT technology was considerably different.

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