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'Statistical uncertainties in various parameters of intracavitary brachytherapy in cervical cancer'

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ABSTRACT: Purpose: The purpose of present study is to find out the statistical variation in Doses within point 'A' (A_{min} and A_{max}) and point B, with respect to (w.r.f) prescription dose (7.5Gy) and to find out the relative variation of OARs (organ at risk) doses w.r.t. prescription dose (7.5Gy).
Materials and Methods: Overall 50 patients diagnosed with carcinoma of cervix (CaCx) were included in this study. They all are planned and treated for 7.5 Gy/# (fraction) for 3 fractions on Bebig HDR multisource (Co-60 source) version 2.6.5.The gap in between the brachytherapy fraction was kept around 7 days. The standard Fletcher suit applicator with various ovoid's diameter (2/2.5/3 cm) and tandem length of 5±1 cm was used during ICRT procedure. The Anterior Posterior and Lateral radiograph was used for planning and dose was prescribed at point A. The bladder and rectum point were marked as per ICRU38 guideline and there maximum dose were noted down respectively.
Result and Conclusion: Variation in doses to point 'A' was found to be within ±4% of prescribed dose 7.5 Gy showing reproducibility of point 'A'.Bladder and Rectum point doses (average) was found to be approximately 57% and 70% respectively which is less enough to avoid late toxicity.

Keywords: Brachytherapy; CT-guided; Cervical cancer; High-dose-rate

Abbreviations: CaCx (carcinoma of cervix), ICRU (International Council of Radiation Units), ICRT (Intra Cavitary Radiation Therapy), Gy (Gray), # (fraction), HDR (High Dose Rate Brachytherapy), A (point of dose prescription), ICBT(Intra Cavitary Brachytherapy), ABS(American Brachytherapy System)

I. INTRODUCTION

The brachytherapy is most commonly used radiation therapy in which radioactive source kept very close to tumor area. It has proven the effective use in treatment of various sites such as prostate, cervix, endometrium, breast, skin, floor of mouth and head & neck cancer. In recent times, Cobalt 60 (^{60}Co) source has been widely used because of its longer half-life (5.27years).It is available in the miniaturized form which is comparable to ^{192}Ir HDR sources and can be used in all modalities of brachytherapy applications (1).In brachytherapy treatment carcinoma of cervix, dose prescription is defined on specifically chosen prescription point A according to guideline of ICRU-38 (2). The point A generally defined at 2 cm superior from the surface of ovoid and 2 cm lateral from the central canal both side (left and right) respectively. Normal tissue tolerance calculated on mainly bladder and rectum point at specific reference point as per ICRU-38 report. It is assumed that position of Fletcher suits applicator used in brachytherapy does not change with relative anatomical structure of patient for duration of implant to irradiation. Prescription of Point A is the average value of combination of point A at left ovoid and right ovoid side. If there is a minute variation of prescribed value than at that anatomical point dose may be over or under depending on higher or lower value.

II. MATERIALS AND METHODS

A total number of 50 patients for ICBT (Intra cavitary brachytherapy) were used for study and implanted with standard Fletcher suit applicator with ovoid size (2 Cm and 2.5 Cm) and the Tandem length of 5±1cm. All cancer patients included in the present study are in 3rd or 4th stage and treated with the combination of EBRT (External Beam Radiation Therapy) and HDR Brachytherapy(3). The EBRT treatment was done with telecobalt unit for 50 Gy/25# and brachytherapy treatment for 22.5Gy/3# on Bebig HDR multisource (Co-60 source) in MDM Hospital, Jodhpur during 2016-2017. The brachytherapy application was done in minor operation theater and packaging with gauze packing in anterior as well as posterior vaginal space area for keeping away bladder and rectum. Two radiograph was taken with help of C-Arm machine one in anterior-posterior and lateral direction. Both images were transferred from C-

Arm to planning station and planning done after calibration of images (Fig.1). The dose was prescribed at Point A and specific reference point of bladder and rectum point marked as per ICRU-38 guideline.The influence of intra patient treatment planning, we calculated the average dose value of all three fractions of 50 patients to the points A, B and ICRU bladder and rectum reference points located in the relevant clinical location.

III. RESULT & DISCUSSION:

Standard deviation of dose at point A_{min} is 0.79% while point A_{max} is 0.82% with dose prescribed at point A is 7.5 Gy. Similarly, standard deviation of point B 0.53%, bladder dose 12.05% and rectum dose 4.32% was found with respect to prescription dose 7.5Gy. A correlation of Point A and point B shows in figure(2). The value of correlation coefficient shows there is a positive correlation. Similarly for point bladder and rectum correlation has also found and graph between these shows variation in bladder and rectum points for all patients in figure (3). All the values showing the statistical nature of parameters have been listed in table (1).

IV. SUMMARY & CONCLUSION

From comparison with ICRU-38 depicts dose delivered to obdurate nodes indicate rates of fall off dosage laterally which is at point B is approximate 20-25 % of point A. Variation of point A shows limitation of ICRU-38 based on anatomical structure. The dose variation shows there is under dose /overdose at point A either side of central tandem (4). The variation in the applicator positioning may result varying location of point A under dose and overdose of either side of point A left and right has change to its volume(5). Similarly for point B. Average value of Point B lies within range given in ICRU-38 (6). The bladder and rectum dose average value shows inside the limit as prescribed by the ICRU-38. For avoiding discrepancy in point A American Brachytherapy System (ABS) recommend prescribing to Point H Which is line connecting the mid dwell position of the ovoid's and find the point this line intersect the tandem(7) . Follow 2 cm superior (along the tandem) plus the radius of ovoid's, then 2 cm perpendicular to the tandem. In bladder and rectum average variation is under the prescribed limit of ICRU-38 but at some point its value is large. Therefore isolated one time dose measurement to normal critical structure should not be used as the sole basis for making therapeutic decision (8). The x-ray radiograph based planning has its own limitations in measurement of dose of OARs, So CT (computed tomography) based planning has to made in practice to overcome such error in marking of points (9).

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Table 1.

Statistical Parameter	A_{min}(%)	A_{max}(%)	A_{avg}(%)
Point A w.r.t. Prescribed Dose(at prescription point)	96.17	103.82	100
Point B w.r.t. PP	23.24	25.69	24.22
Bladder	29.47	77.20	56.82
Rectum	58.80	76.89	69.96

Table-1: Parameters showing the statistical uncertainties with respect to prescription point (PP)* dose (7.5 Gy)

Figure

Figure1

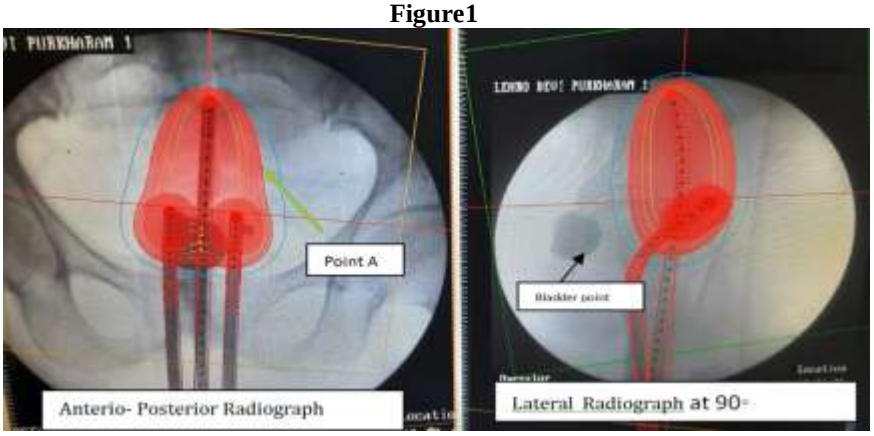

Fig.1 shows planning radiographs taken on C-Arm

Figure.2

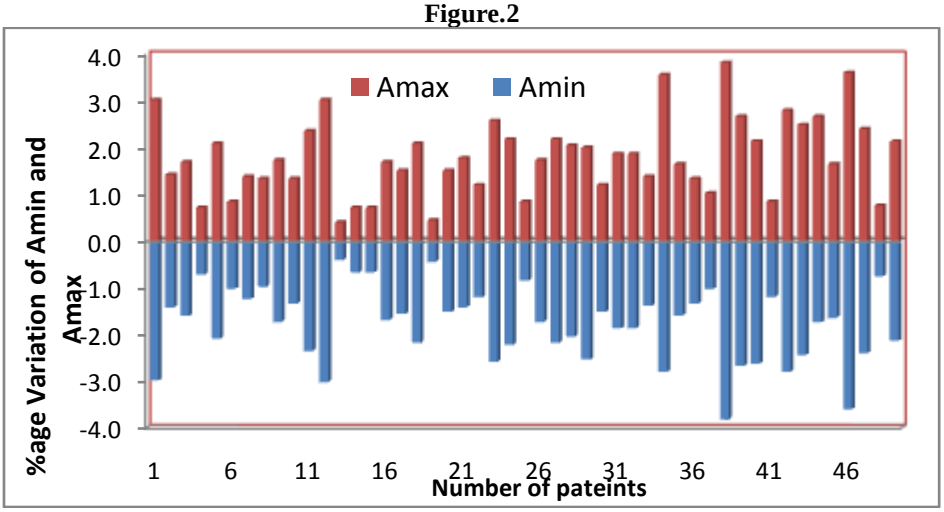

Fig.2 shows variation of absorbed dose within point 'A'

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Figure 3.

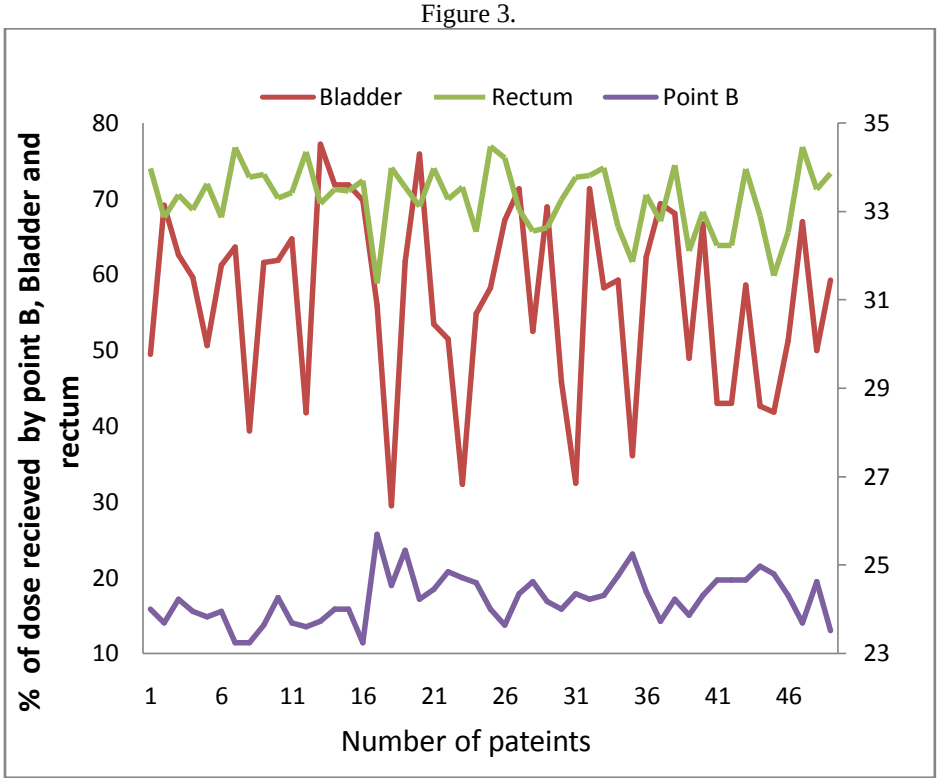

Fig.3 show% of dose recieved by point B, Bladder and rectum