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A DOSIMETRIC COMPARISION OF BLADDER AND RECTAL VOLUMETRIC DOSES IN 3D– CT BASED HDR INTRACAVITARY BRACHYTHERAPY FOR CERVICAL CANCER USING TWO RECTAL RETRACTION METHODS

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Keywords:
Cervical cancer, HDR Brachytherapy, Rectal retractor

Abstract

Introduction: Cervical cancer is a common malignancy among women in India. For locally advanced stages, standard treatment consists of concurrent chemoradiation along with brachytherapy. Most commonly, intracavitary brachytherapy is used. To reduce the radiation dose to the rectum, a rectal retractor is often used. This is sometimes done with vaginal gauze packing also.

Aims: To find out the variation in dosimetric parameters in patients who received 3D CT based intracavitary brachytherapy for cervical cancer based on two rectal retraction methods and if one is dosimetrically non inferior to the other.

Methods: FIGO Stage IIB cervical cancer patients, who received intracavitary brachytherapy with Manchester-style applicator after concurrent chemoradiation, were randomised to either rectal retractor or vaginal gauze packing. Dosimetric parameters of D_{2cc}, V50, Dmax, for rectum and bladder were obtained, along with volume contoured. Paired t-test done for results.

Results: Using t test, the variation in V_{50} for bladder with and without rectal retractor was significant (p=0.017), favouring the arm with packing, but for rectum, it was not statistically significant (p=0.08). Variation in D_{2cc} for bladder (p=0.09) and rectum (p=0.1) was not significant between the two arms.

Conclusion: Vaginal gauze packing may be considered a dosimetrically non inferior substitute to rectal retractor, provided it is done in an adequate manner.

Introduction

Cervical Cancer is one of the most common cancers affecting women in India. The treatment in most cases consists of external radiation to the pelvis, followed by a course of brachytherapy.HDR brachytherapy has now mostly replaced LDR brachytherapy [1]. According to GLOBOCAN 2018 data, the incidence of cancer was 569,847, and the number of deaths caused due to cancer of cervix uteri worldwide was 311,365. Worldwide, Cancer of the cervix is the fourth leading cause of cancer death in females, and the fourth most diagnosed cancer in females [2].This is in contrast to the GLOBOCAN 2012 data, which shows that, worldwide, the incidence of cervical cancer was 527,600, and the mortality was 265,700.According to the GLOBOCAN 2012 data for developing countries, incidence of cervical cancer was 444,500 and the mortality was 230,200.[3].Staging of cervical cancer is done by the International Federation of Gynaecology and Obstetrics (Fédération Internationale de Gynécologie et d'Obstétrique) or F.I.G.O. system.[4]

For Stage IB2 and IIB onwards, the standard of treatment consists of external radiation of 50 Gy to the pelvis along with concurrent weekly cisplatin given at a dose of 40 mg/m^2, followed by a course of brachytherapy, for a Total dose to Point A as LDR equivalent 30 Gy up to total cumulative dose of 80 Gy[5]. Brachytherapy is generally given by the intracavitary method, using various applicators like Manchester-style and Fletcher suite applicators [6][7]. During the intracavitary procedure, the organs at risk(O.A.R.) are the rectum, bladder and small bowel have to be contoured on a CT scan or MRI after the insertion of the intracavitary applicators so that they do not receive more than the maximum tolerated dose[8][9][10[11]. When using Manchester-style applicator, to separate the rectum from the applicator as much as possible, various methods are used, like the rectal retractor, or vaginal packing with sterile gauze.

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Aims

1. To find out the variation in dosimetric parameters in patients who received 3D CT based intracavitary brachytherapy for cervical cancer based on two rectal retraction methods.
2. To compare whether vaginal gauze packing is dosimetrically non inferior to rectal retractor for sparing organs at risk

Methods

It was a single institutional prospective study in a tertiary care hospital in Eastern India. All patients selected were of F.I.G.O. Stage IIB cervical cancer, who had not undergone any prior treatment for the disease, or any prior exposure to radiation therapy. Patients with ECOG performance score > 3 [12] or with non squamous histology were excluded from the study. Patients were randomised to receive intracavitary brachytherapy with either rectal retractor or vaginal gauze packing. The study consisted of 20 patients who received intracavitary brachytherapy for cervical cancer using Manchester-style applicator with 30° central tandem. All patients had received 50 Gy External beam radiation to the pelvis prior to initiation of brachytherapy with ^{60}Cobalt gamma rays (Theratron 780C telecobalt machine), given by parallel opposed antero-posterior and postero-anterior pelvic fields. High Dose Rate brachytherapy was given using remote afterloading technique using Ir^{192} source. Manchester-style tandem and ovoid applicators were used for the procedure.

Aseptic precautions were taken prior to the initiation of the procedure. Foley's catheter was inserted prior to the start of the procedure with 7ml of normal saline in the catheter balloon. Procedure was carried out under sedation using intravenous Midazolam. The external os was identified on examination with a speculum, was dilated with the help of a cervical dilator. A uterine sound was passed through the os to evaluate the intra uterine length and the degree of version, and on this basis, the central tandem was selected and inserted, followed by application of the two ovoids, and then, either the rectal retractor or gauze packing was used to separate the organs at risk from the applicators. Radio opaque dye was injected into the bladder after applicator insertion to ensure proper delineation of the bladder on CT scan. After insertion of the applicator, patients underwent a CT scan to ensure proper application, to exclude the occurrence of perforation and for contouring of the organs at risk. 3mm thickness CT scan slices (Brilliance CT-16 slice with Accusim Visual simulation, Philips Health Care Solutions, DA Best, The Netherlands) were obtained.
CT scan was transferred to the Brachytherapy planning system (Brachyvision TPS, Eclipse, Varian Medical Systems, Palo Alto, California, USA). The OARs contoured based on 3D CT imaging were rectum and bladder. The rectum was contoured 1cm above the anus, and ended at the sigmoid flexure, covering the outer wall of the organ. The bladder was contoured to include the outer wall of the bladder and ended at the start of the urethra.

Dose was prescribed as 7Gy to point A (defined as the point where the uterine artery crosses the ureter) [13] for each fraction for all patients (LDR equivalent of 30Gy) .Plan optimisation was done by geometric as well as changing the dwell time. Rectal retractor was used in half of the patients, and vaginal gauze packing was used for the other half. All patients received a dose of 21Gy over 3 fractions, one fraction per week, using the HDR Brachytherapy machine (GammaMed Plus HDR after-loader unit, Varian Medical Systems). Data was collected regarding:

- D_{2cc} Rectum: The Minimum dose received by the most exposed 2cc of the rectum to radiation. (in cGy)
- D_{2cc} Bladder: The Minimum dose received by the most exposed 2cc of the bladder to radiation. (in cGy)
- V_{50} Bladder: The Volume of bladder receiving 50 percent of prescribed radiation dose (in cc)
- V_{50} Rectum: The Volume of rectum receiving 50 percent of prescribed radiation dose (in cc)
- D_{max} Rectum: The maximum dose received by rectum (in cGy)
- D_{max} Bladder: The Maximum dose received by bladder (in cGy)
- D_{mean} Rectum: Mean dose received by rectum (in cGy)
- D_{mean} Bladder: Mean dose received by bladder (in cGy)
- Volume of rectum contoured (in cc)
- Volume of bladder contoured (in cc)

The study was a prospective study, carried out from January 2018 to May 2018.
Paired t-test was done to calculate the results.

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Data analysis was done using IBM SPSS v.22.

Results

The following figures show:(i) Applicator using vaginal gauze packing.
(ii),(iii)Applicator using Rectal retractor.
In both the figures, rectum is contoured in yellow, and bladder in blue.

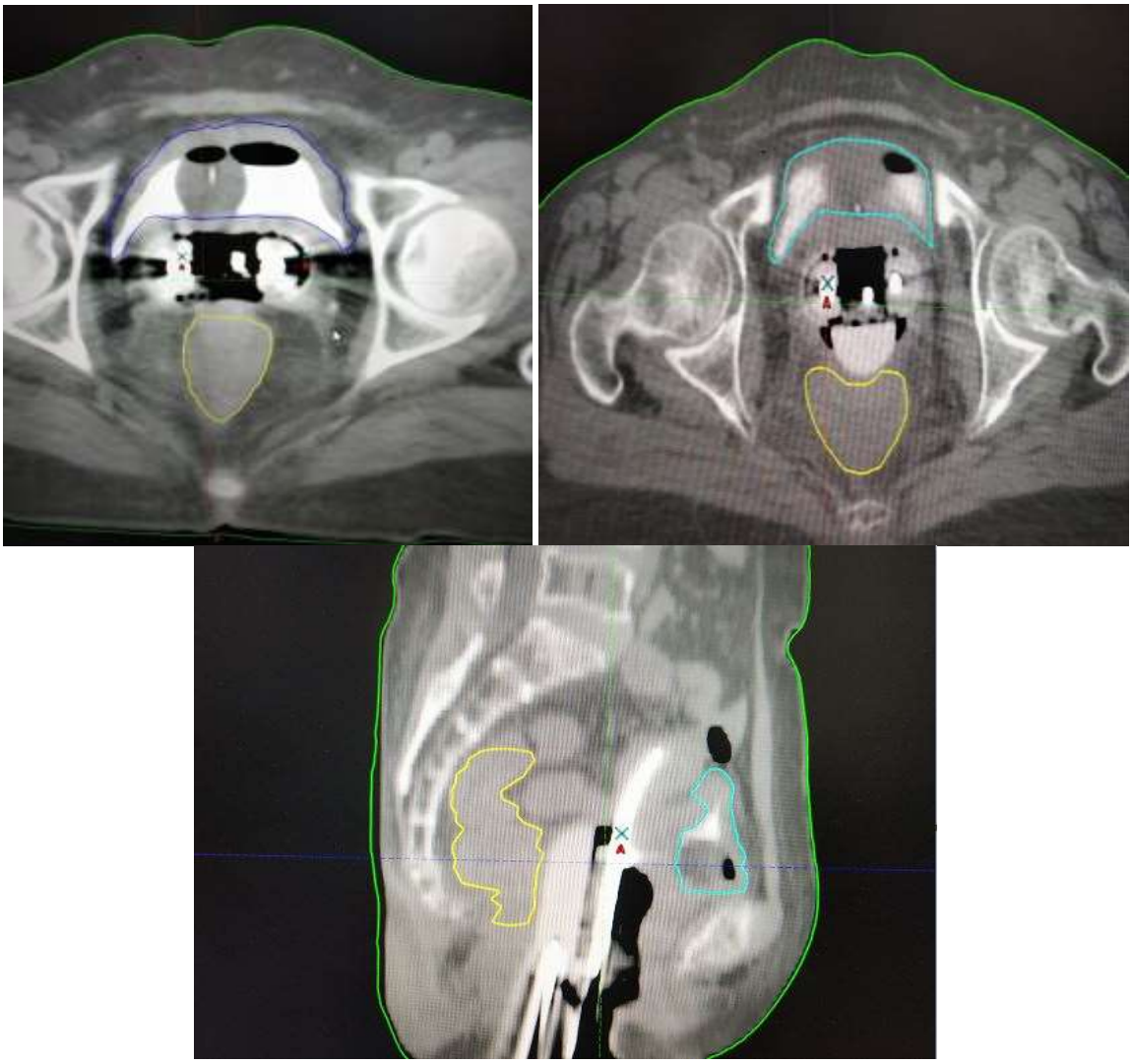

Table 1: Dosimetric data with rectal retractor

SL No	D_{2cc} rectum (cGy)	D_{2cc} Bladder (cGy)	V_{50} Rectum (cc)	V_{50} Bladder (cc)	Mean dose (cGy) Rectum	Mean dose (cGy) Bladder	Rectum volume (cc)	Bladder Volume (cc)	D_{max} rectum (cGy)	D_{max} Bladder (cGy)
1	420.5	428.5	6.9	22.3	251.2	354.6	44.2	52.8	911.4	965.0
2	537.6	424.8	23.5	15.6	306.3	272.6	57.2	45.7	1303.8	706.8
3	355.3	523.4	10.3	26.8	239.2	262.2	48.6	87.9	546.4	865.5
4	474.7	457.7	14.4	13.3	273.5	290.3	63.1	52.5	854.5	105.5

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5	372.0	474.7	6.1	11.6	261.0	293.5	47.8	41.5	821.7	687.0
6	254.1	485.3	13.2	18.9	181.0	334.2	64.0	51.0	403.0	879.0
7	416.1	490.6	8.1	17.8	274.5	360.4	36.7	37.4	781.7	818.5
8	376.2	389.2	5.0	6.5	207.6	220.4	49.8	59.6	853.1	741.2
9	430.6	240.1	13.4	15.3	221.5	140.2	48.0	84.0	930.1	344.9
10	432.0	392.2	7.2	6.8	280.1	260.5	45.2	60.3	920.2	694.0

Table 2: Dosimetric data with vaginal gauze packing

SL no	D2cc rectum (cGy)	D2cc Bladder (cGy)	V50 Rectum (cc)	V50 Bladder (cc)	Mean dose (cGy) Rectum	Mean dose (cGy) bladder	Rectum volume (cc)	Bladder Volume (cc)	Dmax rectum (cGy)	Dmax Bladder (cGy)
1	574.1	486.6	9.8	9.2	331.2	367.3	29.2	29.3	1119.4	1033.9
2	350.1	530.4	4.1	14.0	227.5	304.0	39.4	47.3	597.0	1110.4
3	424.0	426.3	8.3	10.2	196.5	268.0	88.6	43.5	917.0	805.0
4	590.2	584.1	18.1	24.0	342.3	376.0	63.0	66.0	1266.1	1082.2
5	490.3	390.2	16.1	7.3	285.1	268.0	76.6	31.3	820.3	793.2
6	530.8	418.0	15.2	10.6	342.0	279.0	39.2	46.9	875.6	773.0
7	554.1	424.7	20.0	10.0	259.7	251.6	95.4	63.4	935.5	633.3
8	484.0	303.5	28.0	4.19	227.1	293.3	70.9	25.8	1011.1	542.0
9	380.3	524.3	5.66	16.91	232.9	284.3	41.6	66.5	1220.2	1005.0
10	519.2	422.5	15.2	10.6	351.0	285.7	39.7	45.9	882.5	791.6

The Median D_{2cc} for Rectum and bladder for patients with rectal retractor were 416 cGy and 457cGy, and that for patients using vaginal gauze packing were 490 cGy and 420cGy respectively.

Median V_{50} for rectum and bladder were 9.24cc and 16.75cc with rectal retractor, and 15.65cc and 10.3cc by using vaginal gauze packing, respectively.

Median volumes of rectum and bladder respectively contoured by using rectal retractor were 49.8cc and 52.5cc, and 63cc and 46.9cc by packing.
Median D_{max} rectum, with retractor was 853.1cGy and with packing was 935.5 cGy .
Median D_{max} bladder, with retractor was 818.5cGy and with packing was 805 cGy .

Using t test, the variation in V_{50} for bladder with and without rectal retractor was significant (p=0.017), favouring the arm with packing, but for rectum, it was not statistically significant(p=0.08).

Variation in D_{2cc} for bladder (p=0.09) and rectum (p=0.1) was not significant between the two arms.
D_{max} for bladder showed significant variation (p=0.04) when compared between vaginal gauze packing and rectal retractor, favouring lesser D_{max} for vaginal packing.
D_{max} for rectum between the two arms showed statistically significant variation (p=0.008), favouring lesser D_{max} for rectal retractor.

Conclusion

The dosimetric data in our study shows that there was no statistically significant difference in the D_{2cc} of both rectum and bladder received by the two arms. In the arm with vaginal packing, there was a statistically significant lesser V_{50} than in the arm with rectal retractor. D_{max} for bladder was significantly lesser in the arm with vaginal packing, whereas D_{max} for rectum was significantly lesser in the arm with rectal retractor.

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Discussion

The main aim of this study was to compare the dosimetry of two rectal retraction methods used in brachytherapy to treat cervical cancer patients. The results show that, using vaginal packing to separate the organs at risk instead of the conventional rectal retractor is dosimetrically non inferior. D_{2cc} for rectum and bladder showed no variation between the two arms on t-test. However, a study by Gaudet et al [14] a significant decrease in D_{2cc} when rectal retractor was used in place of vaginal packing. However, in our study, the variation in V_{50} was statistically significant for bladder dose, showing that rectal retractor use resulted in a higher V_{50} to bladder than vaginal packing. No such significant variation was seen for V_{50} for rectum between the two arms. Kapp et all [15] showed that vaginal packing reduced the rectal wall dose by 12%. Maximum dose was lower for bladder in vaginal packing, and lower for rectum in patients using rectal retractor, and these variations were statistically significant. Thus, from our study it may be said that vaginal gauze packing is dosimetrically non inferior to rectal retractor in certain aspects. However, there are certain cases where the use of rectal retractor is not advisable [16]. For example, in narrow vaginal vault, use of rectal retractor may result in tearing of the vaginal mucosa. In some cases, use of rectal retractor may also result in more dose to the bladder than if vaginal packing is used, especially in cases of narrow vagina. Also, in cases where the disease extends to the posterior wall, rectal retractor may lead to the diseased area receiving less than optimal dose. Vaginal packing is optimal for such patients. Recently, other techniques like intra vaginal balloon, to separate the organs at risk have also been studied [17].

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