ISSN: 0975-3583,0976-2833 VOL13, ISSUE 02, 2022

ORIGINAL RESEARCH

Comparison Of The Dose Distribution To Planning Target Volume (PTV) And Organs At Risk (OARS) Between IMRT And 3D-CRT Technique With Weekly Injection Of Cisplatin In Cases Of Carcinoma Cervix

[1]Dr Jaspinder Kaur, [2]Dr Parneet Singh, [3]Dr Jaineet Patil

[1]Consultant, Radiation Oncology CCA-SPS Hospitals, Ludiana, Punjab, India
[2]Consultant, Radiation Oncology Paras Hospitals, Panchkula, Haryana, India
[3]Professor, Radiation Oncology, CMC, Ludiana, Punjab, India

Correspondence:
Dr Jaspinder Kaur
Consultant, Radiation Oncology CCA-SPS Hospitals, Ludiana, Punjab, India
Email: drjaspinderkaur13@gmail.com

Abstract

Introduction- In India, Carcinoma of Cervix is one of the most common cancers in women constituting 14.9% of all cancers, after breast cancer. The treatment of cervical cancer presents multidisciplinary and multimodality management. Radiotherapy and surgery remain the most effective and economical methods for the treatment of cervical cancer. Radiotherapy with concurrent Cisplatin based chemotherapy is the standard of care. Recent advances in computer technology have led to improvements on patient compliance like 3D-CRT technique andintensity modulated radiation therapy (IMRT).

Aim- To compare the dose distribution to PTV and OARs between IMRT and 3DCRT techniques with weekly Injection Cisplatin in cases of Carcinoma Cervix.

Material and methods- This prospective and randomized study included histologically proven cases of carcinoma uterine cervix 26 patients was carried out in Department of Radiotherapy, Christian Medical College and Hospital, Ludhiana. Patients were divided into two groups – IMRT group and 3D-CRT group by using web based randomization. Both groups also received weekly chemotherapy with injection Cisplatin 40mg/m^2 with adequate hydration and premedication.

Results - Mean bladder dose was less in IMRT vs 3DCRT by 9% (p = 0.297) . Mean rectal dose and volume in IMRT were both lesser as compare to second group. Both mean dose and volume of small intestine were lesser in IMRT vs 3DCRT. TheV40Gy% was significantly lesser in IMRT vs 3DCRT (p = 0.048). All V10Gy, V20Gy, V30Gy, V40Gy volumes were lesser in IMRT vs 3DCRT.

Conclusion-IMRT was well tolerated with excellent PTV coverage, considerable sparing of surrounding normal tissues, no treatment breaks, better compliance and no patient developing grade3 toxic it Introduction

Carcinoma Cervix is the second most frequent cancer among women worldwide, affecting around five lakh women each year and killing more than two lakh women each year.[1] In India, Carcinoma of Cervix is one of the most common cancers in women constituting 14.9% of all cancers, after breast cancer.[2] It accounted for 16% of all the cancers of women in the urban registries in 2005.[3] Cervical cancer occurs early and strikes at the productive period of a woman's life. The incidence rises in 30-34years of age and peaks at 55-65 years.[4] The treatment of cervical cancer presents multidisciplinary and multimodality management. Radiotherapy and surgery remain the most effective and economical methods for the

ISSN: 0975-3583,0976-2833 VOL13, ISSUE 02, 2022

treatment of cervical cancer. Radiotherapy with concurrent Cisplatin based chemotherapy is the standard of care in locally advanced carcinoma of cervix patients. Early disease can be curatively treated either by surgery or irradiation but patients with locally advanced cervical cancer have a poor prognosis mainly due to failure to control the local disease with radiotherapy even though technique and method so treatment have improved over the Last decade.11 Conventional radiotherapy has provided good tumour control with acceptable toxicity. EBRT isused as the initial treatment which gives a homogenous distribution to the central mass plus the regional lymphnodes. While RT has greatly improved local regional control of primary tumors[5-8], it has come at the cost of significant toxic effects to adjacent non-cancerous tissues.[9,10] In the late 1990s, the technique of three-dimensional conformal radiation therapy (3D-CRT) emerged as a preferred treatment for gynecologic malignancies, since it gave better target coverage and significantly reduced the radiation exposure to the bladder.[11] More recent advances in computer technology have led to improvements on the 3D-CRT technique; one, in particular, being the development of intensity modulated radiation therapy (IMRT).[12-16] In contrast to 3D-CRT, which uses uniform fields, IMRT generates non-uniform fields to achieve better planning target volume coverage, while decreasing unnecessary radiation exposure to normal organs.[13] Concurrent chemoradiation using Cisplatin has resulted in 10-15% improvements in survival in patients with carcinoma cervix. Meta-analysis done by the Cochrane Collaborative group on 19 Randomized Control Trials has shown increase in Overall Survival(OS) by 12% and recurrence free survival(RFS) by 16%, which was statistically significant[17]. IMRT improves dosimetric results, limiting radiation delivered to normal tissue and allowing dose escalation to target volume. Therefore, IMRT has become a common strategy for whole pelvic radiotherapy (WPRT), and has been shown to offer more accurate dose distributions and tighter dose gradients to targets and to reduce toxic risk and undesirable side effects to the rectum, bladder, small bowel, and pelvic bones.[18-21] This study was designed to compare the dose distribution to PTV and OARs between IMRT and 3DCRT techniques with weekly Injection Cisplatin in cases of Carcinoma Cervix.

Material and methods

This prospective and randomized study was carried out in Department of Radiotherapy, Christian Medical College and Hospital, Ludhiana from 1stNovember 2012 to 31stOctober 2013 in all histologically proven cases of carcinoma uterine cervix A total of 26patients were enrolled in this study. Patients who had undergone any surgical intervention or received any chemotherapy prior to the treatment were excluded from the study.

Pre Treatment Evaluation

A complete detailed history and physical examination was done and patients were staged according to FIGO staging(APPENDIXII).[22] Patients under went blood investigations like CBC, RFT and viral markers. Patients underwent metastatic workup: ChestX-ray, USG Abdomen & Pelvis and MRI pelvis. After an informed consent patients were taken up for a planning CT scan.

Patients were divided into two groups – IMRT group and 3D-CRT group by using web based randomization. Both groups also received weekly chemotherapy with injection Cisplatin 40mg/m^2 with adequate hydration and premedication. A computed tomography (CT) scan of each patient. The scan parameters consisted of a large field-of-view pelvic protocol with a3-mm slice thickness for 3DCRT and IMRT. The CT scans were obtained from the T12vertebral body to 5-cm below the is chial tuberosities. Oral contrast and Intravenous contrast(CONTRAPAQUE)were administered to all patients before CT scan. These images were then transferred to treatment planning system CMSXio and after that tumor and

ISSN: 0975-3583,0976-2833 VOL13, ISSUE 02, 2022

normal tissue delineation done. Three targets were delineated in all the patients based on ICRU50: Gross tumour volume(GTV), Clinical target volume(CTV), Planning target volume(PTV). For organ at risk deteremination- the rectum and bladder were contoured for each patient. Entire rectum and bladder were contoured. The rectum was defined from the level of the sacral promontory to the ischial tuberosities. The peritoneal cavity (excluding the rectum and bladder) from the level of aortic bifurcation (L4-5) was used to define the small bowel region (SBR). The individual loops of small bowel were not separately contoured. The 3D-CRT and IMRT plans were generated using Treatment Planning System CMSXiO4.6. The prescribed total dose was 50.4Gy in 28 fractions. All patients were followed up weekly during treatment. Portal imaging was done weekly to ensure proper treatment delivery. 12 out of total 26 patients were included in IMRT group and 14 out of total 26 patient in 3DCRT group based on web randomization table. Patients were treated with 6 MV Elekta linear accelerator equipped with a multi- leaf collimator. Treatment was delivered in the step and shoot mode. The accuracy of the setup was verified on the first day of treatment by matching the DRR(digitally reconstructed radiograph) with EPID (electronic portal imaging device) and then weekly with EPID. These films were checked before treatment. Patients were followed up monthly and response was assessed. All patients were followed up for a minimum period of six months. At each visit, the clinical history was updated and a complete physical examination including pelvic examination was done. Basic Laboratory tests were performed. Chest X-ray and USG abdomen / pelvis was repeated every three months. Pap smear was done at six months.

Descriptive statistical analysis has been carried out in the present study. Results on continuous measurements are presented on Mean ± SD (Min-Max) and results on categorical measurements are presented in Number (%). Chi-square test and Student T- test has been used to find the significance of study parameters on categorical scale between two or more groups.

Results and observations

A total of 43 patients of Carcinoma cervix presented to Radiotherapy OPD in the 1 yearstudy period. Out of these, only 26 patients could be included in the study. Rest 17patients were either post-op, had already received treatment outside, had metastatic disease at presentation or were not deemed fit for concurrent chemotherapy. Patients were divided into two study groups: IMRT and 3DCRT groups, using a web generated randomized plan. Out of the total 26patients included in this study, 12pts were in IMRT group and 14 pts were in 3DCRT group. Patients were examined and clinical staging was done by FIGO, underwent metastatic workup and investigations according to protocol. In our study, the mean volume of PTV was 1280.46 cc in IMRT as compared to 1409.05cc in 3DCRT group(p=0.527). The mean dose of PTV was 5083.83cGy in IMRT group while it was 4966.64cGy in 3DCRT group (p = 0.093) which was not statistically significant.

Table 1: Comparison Of Mean Volume And Mean Dose Received By PTV

Ptv	IMRT MEAN	3D-CRT MEAN	PVALUE
VOLUME cc	1280.45+/-519.84	1409.05+/-499.04	.527
MEAN DOSE cGy	5083.83+/-106.91	4966.64+/-209.58	.093

ISSN: 0975-3583,0976-2833 VOL13, ISSUE 02, 2022

Table 2: Volumetric analysis of Mean Dose Received By Bladder

BLADDER	IMRT	3D-CRT	
	MEAN+/-SD	MEAN+/-SD	PVALUE
VOLUME cc	231.60+/-75.42	253.41+/-141.83	.638
MEAN DOS EcGy	3780.58+/-1137.37	4243.28+/-1071.60	.297
V10Gy %	100.00	100.00	.
V20Gy %	100.00	100.00	.
V30Gy %	97.73 ± 5.28	97.32 ± 6.22	.859
V40Gy %	90.65 ± 9.71	87.32 ± 11.52	.438

The V10Gy and V20Gy was less in IMRT (223.32 cc) as compared to 3DCRT (233.44cc). V30Gy was 214.89 in IMRT and 225.78cc in 3DCRT group. V40Gy was less in IMRT (186.29 cc) whereas in 3DCRT group, it was 198 cc (p = 0.753) which was not statistically significant. All volumes are lesser in IMRT as compared to 3DCRT.

Table 3: Volumetric analysis of Mean Dose Received By rectum

RECTUM	IMRT	3D-CRT	
	MEAN+/-SD	MEAN+/-SD	PVALUE
VOLUME cc	66.14+/-28.62	87.81+/-42.03	.144
MEAN DOSE cGy	3845.91+/-1145.57	3980.85+/-1084.06	.761
V10Gy %	99.85 +/- 0.41	99.52 +/- 1.76	.537
V20Gy %	99.17 +/- 1.95	96.66 +/- 8.07	.305
V30Gy %	90.50 +/- 7.31	95.15 +/- 14.18	.317
V40Gy %	79.23 +/- 24.06	77.23 +/- 22.41	.829
V10Gy cc	61.23 +/- 32.91	80.07 +/- 43.36	.230
V20Gy cc	60.73 +/- 32.71	78.08 +/- 43.98	.272
V30Gy cc	58.61 +/- 33.30	73.32 +/- 43.34	.348
V40Gy cc	49.91 +/- 35.88	63.82 +/- 41.30	.373

In our study, the mean rectum volume in IMRT group was 66.14cc while in 3DCRT group, it was 87.81cc (p = 0.144) and this difference was not statistically significant. The mean rectal dose in IMRT group was 3845.92 cGy whereas it was 3980.86 cGy in 3DCRT group (p=0.761) which was not significant. The V10Gy was 99.86% in IMRT while it was 99.53% in 3DCRT group (p = 0.537).V20Gy was 99.18% in IMRT while 96.67% in 3DCRT. The V30Gy was 90.50% in IMRT group while it was 95.15 % in 3DCRT group (p = 0.317). V40Gy was calculated to be 79.23% in IMRT arm as compared to7 7.24% in 3DCRT arm (p=0.829).

Table 4: Dose–Volumetric Comparison Of OARS Volumes Receiving >30gy

VOLUME CC	IMRT	3D-CRT	
	MEAN±SD	MEAN±SD	PVALUE
Bladder>30Gy	186.29±90.86	198±88.058	.753
Rectum>30Gy	49.919±35.881	63.822±41.29	.373
RPelvis>30Gy	178.53±55.113	179.48±50.77	.964
LPelvis>30Gy	172.76±63.86	186.57±41.75	.514
LSC>30Gy	238.52±81.52	235.87±73.6	.931
SINT>30Gy	299.94±222.523	325.51±245.11	.784

In our study, we also analysed and compared the volume of different OARs receiving >30Gy of total dose. The >30Gy volume for bladder was 186.29 cc in IMRT group while it was 198 cc in 3DCRT group (p = 0.753). For rectum, the > 30Gy volume was 49.91 cc in IMRT arm as compared to 63.82cc in 3DCRT arm (p= 0.373).

ISSN: 0975-3583,0976-2833 VOL13, ISSUE 02, 2022

In case of small intestine, the > 30Gy volume was 299.94 cc in IMRT group while it was high 325.51cc in 3DCRT group with pvalue of 0.784 which was statistically not significant (p=0.784). For right pelvis, it was 178.53cc in IMRT arm as compared to 179.48 cc in 3DCRT group (p = 0.964). The > 30Gy volume for left pelvis was 172.76 ccin IMRT and it was 186.57 cc in 3DCRT (p = 0.514) . For lumbo sacrum, the > 30Gyvolume was 238.52 cc in IMRT group as compared to 235.87 cc in 3DCRT group (p =0.931).

Discussion

In our study, 26 patients with histologically proven Carcinoma Uterine cervix were randomized into two study groups: IMRT and 3DCRT. The dose of EBRT delivered was 50.4 Gy in 28 fractions in both groups. All patients received concurrent chemotherapy with Inj. Cisplatin 40mg/m^2 weekly as a radio sensitizer. All patients received HD Rintra-cavitary brachy therapy after completion of EBRT either to a dose of 7Gy / 3 fractions or9Gy/2fractions. Peter G. Rose et al concluded that regimens of radiotherapy and chemotherapy that contain cisplatin improve the rates of survival and progression-free survival among women with locally advanced cervical cancer.[23]IMRT is increasingly being used to treat cervical cancer. Subsequent early reported series of patients treated with IMRT showed dosimetric and clinical benefits, with reduction in acute gastro intestinal and hematologic toxicity.

In our study, the mean volumes of different OARs (bladder, rectum, small intestine, pelvic bones) were less in IMRT arm as compared to 3DCRT arm. Heron DE et al advocates the advantage of IMRT over 3DCRT as it results in significant reduction in treatment volume for bladder, rectum, and small bowel. It is anticipated that this reduction in volume of normal tissue irradiated would translate into overall reduction in acute and potentially late treatment-related toxicity.[24]

The mean dose of PTV was 5083cGy in IMRT arm whereas it was 4966cGy in 3DCRT arm. Hence the dose distribution of PTV was better in IMRT group.

The pooled average percent irradiated volumes of IMRT and 3D-CRT were calculated for different OARs and compared for each irradiated level 10Gy, 20Gy, 30Gy, 40Gy.

In our study, for urinary bladder, the V10 Gy and V20Gy was 100% in both study arms though the volume was less in IMRT (223.32 cc) as compared to 3DCRT (233.44 cc).V40Gy % was higher in IMRT arm than 3DCRT arm though V40Gy cc was less in IMRT(186.29 cc)whereas in 3DCRT group, it was 198 cc(p = 0.753) which was not statistically significant. Hence the bladder dose was less in IMRT arm as compared to 3DCRT arm. In a study by Portelance et al. in which they demonstrated that with similar target coverage, normal tissue sparing is superior with IMRT in the treatment of cervical cancer, the fractional volume of bladder receiving the prescribed dose and higher was as follows: four fields, 30.29 ± 4.64%; seven fields, 31.66 ± 8.26%; and nine fields, 26.91 ± 5.57%. It was significantly worse with the two-field (92.89 ±35.26%) and with the four-field (60.48 ±31.80%) techniques ($p<0.05$) as compared to IMRT (nine fields).[20]

In our study, the mean rectal dose and volume were less in IMRT as compared to3DCRT. IMRT decreased the V30Gy % as compared to 3DCRT. All the V10 – V40 Gy volumes were lower in IMRT as compared to 3DCRT (p = 0.373). These results were not statistically significant. But the analysis showed that the volume of normal rectal tissue which receives part of the prescribed dose to tumour is less in IMRT arm as compared to 3DCRT arm. This would result in less acute lower GI toxicity in IMRT group and better compliance to treatment.

The studies by Heron et al, Igdem et al, and Roeske et al reported that IMRT at doses of30 Gy, 40 Gy, and 45 Gy significantly reduced the irradiated volume of the rectum, as compared to 3D-CRT.[24-26] Chen et al. reported that, when patients received 70% of the prescribed dose

ISSN: 0975-3583,0976-2833 VOL13, ISSUE 02, 2022

with IMRT, the average percent volume of irradiated rectum was significantly less ($p < 0.05$).[27] However, the study by Mell et al. found no significant reduction in average percent volumes irradiated by IMRT at those same doses.[28] Baojuan yang et al showed in their meta-analysis that the pooled average percent volumes of irradiated rectum (at doses of 30Gy, 35Gy, 40Gy, and 45Gy) were significantly lower in IMRT than in 3D-CRT.[5] Similar results were seen in our study also. In a study by Baojuan yang et al, in small bowel, the pooled average percent volumes were significantly lower (by 17.80%) for IMRT than for 3D-CRT at a radiation dose of 40Gy (IMRT: 24.70%) and 3D-CRT: 42.50% ($p = 0.043$). Comparable results were seen in our study also. Similarly, at a dose of 45 Gy, the pooled average percent volumes were17.30% lower in IMRT (18.60%) and 3DCRT: 35.90% ($p = 0.012$). At low doses (<20 Gy), the pooled average percent volumes of small bowel irradiated with IMRT were similar to those for patients who received 3D-CRT treatment ($p > 0.05$). Likewise, the doses between 25Gy and 35Gy did not produce significantly different effects[5]

In our study, comparison of the volumes of OARs receiving more than 30Gy dose showed that volumes were less in IMRT arm as compared to 3DCRT arm. The >30 Gy volume for bladder was 186 cc in IMRT arm while it was 198 cc in 3DCRT arm. For rectum, > 30 Gy volume was 49.9 cc in IMRT group as compared to 63.8 cc in 3DCRT. The >30Gycc volume for right pelvis was 178.5cc in IMRT arm while it was 179.48cc in 3DCRT arm. For left pelvis, the >30 Gy volume was 172.7cc in IMRT group IMRT arm while it was 235.8cc in 3DCRT arm. In a study by Heron DE et al, the volume of each organ of interest (small bowel, bladder, and rectum) receiving doses in excess of 30 Gy was compared in the 3DCRT and IMRT treatment plans.[24] The mean volume of small bowel receiving doses in excess of 30 Gy was reduced by 52% with IMRT compared with 3DCRT. A similar advantage was noted for the rectum (66% reduction) and the bladder (36% reduction). They concluded that IMRT appears to offer several advantages over conventional 3D radiotherapy (3DCRT) planning for adjuvant radiotherapy for gynecologic malignancies. These include a significant reduction in treatment volume for bladder, rectum, and small bowel. Similar results were seen in our study also.

Conclusion

In our study IMRT is shown to have decreased dose to OARs such as bladder, rectum, small intestine and pelvic bone marrow which in turn translated to lesser acute toxicity, better tolerance and compliance to chemo radiotherapy in the IMRT group.

IMRT was well tolerated with excellent PTV coverage, considerable sparing of surrounding normal tissues, no treatment breaks, better compliance and no patient developing grade 3toxicity. Further multi institutional studies and longer follow up are required for Conclusive evidence of the superiority of IMRT over 3DCRT.

References

1. Parkin DM, Bray F, Ferlay J, Pisani P. Global Cancer Statistics, 2002. CA Cancer JClin2005;55:74-108.
2. Raina V, Tyagi BB, Manoharan N. Population based cancer registry, Delhi. Dr BRAmbedkar Institute Rotary Cancer Hospital, All India Institute of Medical Sciences,NewDelhi.IndividualRegistryData2001
3. Nandakumar A, Ramnath T, Chaturvedi M. The magnitude of Carcinoma cervix inIndia.IndianJMedRes2009;130:219-21.
4. KaarthigeyanK. Cervical cancer in India and HPV vaccination. IJMC2012;33:7–12.
5. Yang B, Zhu L, Cheng H, Li Q, Zhang Y, Zhao Y. Dosimetric comparison of intensity modulated radiotherapy and three-dimensional conformal radiotherapy in patients with gynecologic malignancies: a systematic review and meta-analysis. Radiation Oncology

ISSN: 0975-3583,0976-2833 VOL13, ISSUE 02, 2022

2012;7:197.
6. Rose PG, Bundy BN, Watkins EB, Thigpen JT, Deppe G, Maiman MA et al. Concurrent cisplatin-based radiotherapy and chemotherapy for locally advanced cervical cancer. NEnglJMed 1999;340:1144–53.
7. Warlam-Rodenhuis CC, De Winter KA, Lutgens LC, Bergh AC, Banasik E, Beerman Het al. Surgery and postoperative radiotherapy versus surgery alone for patients with stage-1 endometrial carcinoma: multi centre randomized trial: PORTEC Study Group. Lancet2000; 355:1404–11.
8. Papp Z, Csapo Z, Mayer A, Hupuczi P. Wertheim-operation: 5-year survival of 501consecutive patients with cervical cancer. OrvHetil2006;147:537–45.
9. YeohE: Radiotherapy: long-term effects on gastro intestinal function. Curr Opin Support Palliat Care2008;2:40–4.
10. Vargas C, Martinez A, Kestin LL, Yan D, Grills I, Brabbins DS et al. Dose-volume analysis of predictors for chronic rectal toxicity after treatment of prostate cancer with adaptive image-guided radiotherapy. IntJRadiatOncolBiolPhys2005;62:1297-08.
11. Gerstner N, Wachter S, Knocke TH, Fellner C, Wambersie A, Potter R. The benefit ofBeam's eye view based 3D treatment planning for cervical cancer. Radiother Oncol1999;51:71–8.
12. PurdyJA. Intensity-modulated radiation therapy. IntJRadiatOncolBiolPhys1996;35:845–46.
13. SawCB, AyyangarKM, EnkeCA. MIMiC-based IMRT-partI. MedDosim2001;26:1.
14. SawCB, AyyangarKM, EnkeCA: MLC-based IMRT-PartII. MedDosim2001;26:111–12.
15. Bucci MK, Bevan A, Roach M. Advances in radiation therapy: conventional to 3D, to IMRT, to 4D, and beyond. CACancerJClin2005;55:117–34.
16. Miles EA, Clark CH, Urbano MT, Bidmead M, Dearnaley DP, Harrington KJ et al. The impact of introducing intensity modulated radiotherapy into routine clinical practice. Radiother Oncol2005;77:241–46.
17. BenedetJL, OdicinoF, MaisonneuveP, BellerU, CreasmanWT, HeintzAP, etal. Carcinoma of the cervixuteri. IntJGynaecolObstet2003;83:41-78.
18. NuttingCM, ConveryDJ, CosgroveVP, RowbottomC, PadhaniAR, WebbSetal. Reduction of small and large bowel irradiation using an optimized intensity-modulated pelvic radiotherapy technique in patients with prostate cancer. Int JRadiatOncolBiolPhys 2000;48:649–56.
19. Intensity-modulated radiotherapy: current status and issues of interest. Int J RadiatOncolBiolPhys2001;51:880–914.
20. Portelance L, Chao KS, Grigsby PW, Bennet H, Low D. Intensity-modulated radiation therapy (IMRT) reduces small bowel, rectum, and bladder doses in patients with cervical cancer receiving pelvic and para-aortic irradiation. Int J Radiat Oncol BiolPhys 2001;51:261–66.
21. Georg P, Georg D, Hillbrand M, Kirisits C, Potter R. Factors influencing bowel sparing in intensity modulated whole pelvic radiotherapy for gynaecological malignancies. RadiotherOncol2006;80:19–26.
22. PecorelliS, ZiglianiL, OdicinoF. Revised FIGO staging for carcinoma of the cervix. IntJGynecolObstet2009;105:107-8.
23. Rose PG, Bundy BN, Watkins EB, Thigpen JT, Deppe G MM. Concurrent cisplatin-based radiotherapy and chemotherapy for locally advanced cervical cancer. New England Journal of Medicine1999;340:1144-53.
24. Heron DE, Gerszten K, Selvaraj RN, King GC, Sonnik D, Gallion H et al. Conventional 3D con formal versus intensity-modulated radiotherapy for the adjuvant treatment of gynecologic malignancies: a comparative dosimetric study of dose-volume histograms.

ISSN: 0975-3583,0976-2833 VOL13, ISSUE 02, 2022

GynecolOncol2003;91:39–45.
25. Roeske JC, Lujan A, Rotmensch J, Waggoner SE, Yamada D, Mundt AJ. Intensity-modulated whole pelvic radiation therapy in patients with gynecologic malignancies. IntJRadiatOncolBiolPhys 2000;48:1613–21.
26. IgdemS, ErcanT, AlcoG, ZenginF, OzgulesR, GeceerGetal. Dosimetric comparison of intensity modulated pelvic radiotherapy with 3D conformal radio therapy in patients with gynecologic malignancies. EurJGynaecolOncol2009;30:547–51.
27. ChenMF, TsengCJ, TsengCC, KuoYC, YuCY, ChenWC. Clinical outcome in post hysterectomy cervical cancer patients treated with concurrent Cisplatin and intensity-modulated pelvic radiotherapy: comparison with conventional radio therapy. IntJRadiatOncolBiolPhys 2007;67:1438–44.
28. MellLK, KochanskiJD, RoeskeJC, HaslamJJ, MehtaN, YamadaSD et al. Dosimetric predictors of acute hematologic toxicity in cervical cancer patients treated with concurrent cisplat in and intensity-modulated pelvic radiotherapy. Int JRadiat Oncol Biol Phys2006; 66:1356-65.