Indian Journal of Obstetrics and Gynecology Research 6 (2019) 302–307

Content available at: iponlinejournal.com

Indian Journal of Obstetrics and Gynecology Research

Journal homepage: www.innovativepublication.com

Original Research Article

# Evaluation of adequacy of conventional radiotherapy fields based on bony landmarks in cervical cancer patients using contrast enhanced computed tomography scan- A regional cancer centre experience

**Deepak Tuli[1], Purnima Thakur[1,*], Manoj Gupta[2], Rajeev K Seam[3], Manish Gupta[4]**

[1] *Dept. of Radiotherapy, Indira Gandhi Medical College, Shimla, Himachal Pradesh, India*
[2] *Dept. of Radiotherapy, All India Institute of Medical Sciences, Rishikesh, Uttarakhand, India*
[3] *Dept. of Radiotherapy, MMU, Ambala, Haryana, India*
[4] *Dept. of Radiotherapy, Indira Gandhi Medical College, Himachal Pradesh, India*

ARTICLE INFO

*Article history:*
Received 17-7-2019
Accepted 19-7-2019
Available online 12-09-2019

*Keywords:*
Cancer cervix
Conventional simulator
Bony landmarks

ABSTRACT

**Objective:** Knowing that there is a wide variation in pelvic anatomy worldwide, it was an instinctive query that whether radiotherapy planning in cancer cervix by four field box technique based on GOG (gynaecologic oncology group) defined field carries adequacy and justification in our region. A prospective trial was conducted at a Regional Cancer Centre located in Northern India, from August 2014 to July 2015. CECT (contrast enhanced computed tomography) abdomen and pelvis was done in newly diagnosed 64 patients of cervical cancer with stage IB to IIIB. Using vessels as surrogates for lymph nodes, adequacy of radiation portals using bony landmarks defined by GOG were assessed.

**Materials and Methods:** 2D (two dimensional) radiation portals were designed on conventional simulator ”Acuity” as per GOG recommendations. CECT pelvis from L1(first lumbar) to mid femur was done in the same position along with same immobilization accessories used during conventional simulation. Three parameters D1, D2 and D3 were defined for adequacy of superior, lateral, and anterior portals respectively.

**Results:** Increasing the length of AP:PA portal cranially by 4.5 cm will cover the proximal common iliac nodes adequately. The width of the AP: PA portal needs to be increased by 3.6 cm to cover the distal external iliac nodes adequately.

**Conclusions:** Conventional pelvic fields failed to cover all of pelvic lymph nodes in majority of this study population. Diagnostic CT and MRI are suggested to be referenced to plan pelvic fields precisely when CT simulation is not available.



## 1. Introduction

Cervical cancer is the third most common malignancy in women worldwide.[1] However, in India, it is second only to breast cancer in females. In Himachal Pradesh an Indian State situated in Western Himalayas, it is the most common gynaecological malignancy in the fairer sex.[2] At our institute, carcinoma of uterine cervix accounts for approximately 58.6% of all gynaecological malignancies with about 80-90% patients presenting in advanced stage with bulky central disease.[3]

Presently, pelvic radiation fields are still planned based on conventional bony landmarks in many centres in India. Approximately 5%~50% of patients with radiotherapy would relapse ultimately in their pelvis.[4] This loco-regional failure may be caused by inadequate pelvic radiation coverage for the draining lymph nodes. Although it is known that in Western women, the conventional pelvic fields based on bony landmarks provided inadequate coverage for pelvic lymph nodes in cervical cancer,[5,6] it remains unclear in Indian patients because of the pelvic anatomic discrepancies. Therefore, a prospective study was conducted with an aim to assess the adequacy of radiation portals relying on GOG based bony landmarks. This is the

* *Corresponding author.*
*E-mail address*: purnimathakur28@gmail.com (P. Thakur).

https://doi.org/10.18231/j.ijogr.2019.068
2394-2746/© 2019 Published by Innovative Publication.

first study of its kind in Northern India.

## 2. Materials and Methods

This prospective study was conducted in the Regional Cancer Centre, Himachal Pradesh in 64 patients of cancer cervix, presenting from August 2014 to July 2015.

Stage IB2 to IIIB cervical cancer cases, histologically proven- invasive squamous cell carcinoma, adenocarcinoma and adenosquamous carcinoma are included in the study. Those with deranged kidney function and hypersensitivity to contrast agent used in CT scan are excluded from the study. Signed informed consent was taken from all the patients included in the study.

### 2.1. Study Design

### 2.2. Step I

2D radiation portals were designed on conventional simulator "Acuity" as per GOG recommendations. On the anterior/posterior (AP-PA) field, L4-L5 inter-space was identified as the superior border and the inferior aspect of the obturator foramen was labelled as the inferior border (if vaginal involvement is positive, inferior border was extended by 3cms). The lateral border was allocated at 1.5 cm beyond the widest part of the pelvic brim. On the lateral (LAT) field, the most anterior part of the symphysis pubis was identified as the anterior border, and whole of sacrum was included in the posterior border. The superior and inferior borders were identical to those on the AP fields.

### 2.3. Step II

CT Scan done on 64 slice MDCT scanner (Light speed VCT XTe, GE Medical System) with slice thickness of 5mm reconstructed to 0.625 mm. CECT was done in the same position along with same immobilization accessories as used during conventional simulation. For calculation of first parameter of study viz. D1 for adequacy of superior border of AP/PA portal the following steps were followed-

Firstly level of division of aorta was marked on coronal CT image.

After this we measured the distance between L4-L5 inter-space which is the upper border of AP-PA field as defined in conventional simulator and aortic bifurcation.

For obtaining the first parameter D1 we used following methodology:

1. If the aortic bifurcation was cranial to upper border of anterior field we added 20mm (10 mm for planning tumour volume i.e. PTV & 10 mm for Penumbra) to this measured distance, and the total distance so obtained was assigned a minus (negative) sign signifying inadequacy.
2. In case the aortic bifurcation was caudal to the upper border of the AP: PA portal, then 20 mm was subtracted.
3. For all such values so obtained, turns out to be a positive integer, it indicated adequacy of upper border of AP:PA field and all the values in negative integers indicated inadequate upper border.

Next step was to calculate second parameter D2 for adequacy of width of AP: PA portal for which we used following methodology-

We measured the distance between EIA (external iliac arteries) at the level of superior border of head of femur (lower most and farthest placed external inguinal lymph nodes). We recognized this distance as negative if it was less than the width of AP: PA portal (GOG defined) and vice versa. Later we deducted this distance from AP: PA portal width and recognized the distance to be negative (-sign) integer if this distance is less than the width of AP: PA portal and in second situation if distance is more than the width of AP: PA portal we deducted width of AP:PA portal from this distance and identified it to be positive(+sign) integer.

Following this we added 54mm to the difference obtained to account for 7mm on each side for CTV (clinical target volume), 10mm on each side PTV and again 10 mm on each side for penumbra. The value so obtained if positive, signified inadequacy of width of AP:PA field as defined on conventional simulation. The negative value or zero signified the adequacy of the portal.

For calculation of third parameter i.e. D3 we used the following methodology-

First we obtained distance between external iliac artery and anterior most part of symphysis pubis at the level of superior part of head of femur (anterior most part of symphysis pubis corresponds to anterior margin of the lateral field as defined on conventional simulator). From this distance we substracted 27 mm to account for 7 mm for CTV, 10 mm for PTV & 10 mm for Penumbra and the value so obtained was labelled as D3. The negative value of D3 reflected the inadequacy of coverage for external iliac LNs by anterior border of lateral field as defined on conventional simulator and a positive value or zero signified adequacy.

### 2.4. Analysis

The measurements of D1, D2, and D3 were obtained for every patient. Separate mean, standard deviation and range were calculated for each measurement.

## 3. Results

Total number of patients included in the study were 64. Mean age of the study population was 53.77 ± 8.08 yrs. Patients enrolled mainly belonged to FIGO stage IIB and IIIB. Data obtained after analysis of pelvic field borders is depicted in Table 1.

Analysis of this data clearly depicts failure of upper and lateral margin of GOG field in AP field and anterior border of GOG defined lateral field in encompassing pelvic lymph nodes in majority of the patients.

Statistical analysis of the three parameters (D1,D2,D3) is shown in Table 2.

**Table 1:** Analysis of various borders of pelvic field

| Adequacy of borders | D1 | D2 | D3 |
|---|---|---|---|
| Adequate | 1 | 0 | 2 |
| Inadequate | 63 | 64 | 62 |
| Total | 64 | 64 | 64 |

In this study, on analysis of our defined parameters viz. D1, D2 and D3, mean and median almost coincided and the distribution curves with individual data also showed normal distribution of the variables. Mean and median for D1 was -43.11 & -43.30 with standard deviation of 14.95, for D2, mean and median was 3.36 &3.32 with standard deviation of 1.25 and mean and median for D3 was -13.42 & -15.15 with standard deviation of 7.70.

On extrapolation of our results i.e. if distance equal to three times standard deviation is added to the mean of variables obtained, we can make our variables adequate in 99.7% of our study population.

This translates into increasing the length of AP:PA portal cranially by 4.5 cm which will cover the proximal common iliac nodes adequately in almost all the patients. Similarly the width of the AP: PA portal needs to be increased by 3.6 cm to cover the distal external iliac nodes adequately. In lateral pelvic field, the field is to be increased by 2.25 cm anteriorly to cover the distal external iliac nodes.

In all the three parameters, mean and median are almost coinciding in all cases, signifying that the variables seen in this study are showing nearly normal distribution. In other words if more cases from the same population are included in the study, it is very unlikely that they will show different results than the study group.

## 4. Discussion

Although the concurrent chemo-radiotherapy in cancer cervix has recently improved their curative effect to a certain extent, loco-regional relapse rates still remain high, especially in pelvic lymph node regions. Radiotherapy is widely used as primary treatment for locally advanced cervical cancer and adjuvant therapy for early disease.

In a country like ours, due to limited resources and patient burden, the use of conventional simulator for radiotherapy planning of cancer cervix is still widely prevalent. Bony landmarks used for conventional planning is based largely on textbook anatomic landmarks. Region specific variation in anatomical landmarks is a distinct possibility. Optimization of radiation field parameters to improve the cure is crucial. In Indian women, the relationship between conventional pelvic fields and pelvic lymph node coverage has not been demonstrated.

Contrast enhanced CT scan is routinely used in patients of carcinoma cervix to assess the lymph node status and extent of disease and sometimes to evaluate the response to treatment. So, using CECT in assessing planning of the patient using conventional bony landmarks in addition to its other utilities is a justifiable and beneficial approach.

An optimal external irradiation to prevent the loco-regional relapse requires an adequate coverage of the pelvic lymph nodes, as it is known to be one of the most common site of relapse in cancer cervix. Conventional pelvic field borders planned on bony landmarks as indicative of lymph node location have been used for several decades. However, in many cases conventional pelvic fields based on bony landmarks could not provide adequate radiation coverage.[5–7]

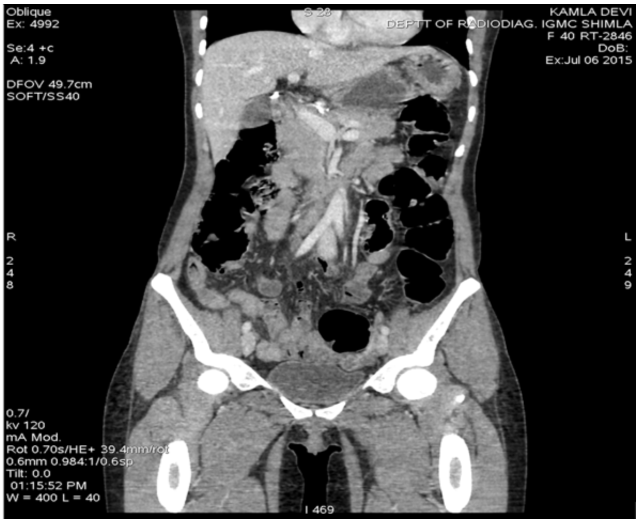


**Fig. 1:** Coronal section CT image for marking divisionof aorta

In the current study, CECT was used to assess the adequacy of GOG defined field based on bony landmarks, for coverage of pelvic lymph nodes in cancer cervix cases. The results confirmed that the conventional radiation fields usually did not have adequate coverage of pelvic lymph nodes.

Our data clearly indicates that the length of the AP:PA field is to be increased by 4.5cm cranially to adequately cover the proximal common iliac nodes. Similarly the width of the AP: PA field is to be increased by 3.6cm and anterior border of the lateral field by 2.25cm to cover the distal external iliac nodes adequately in majority of our patients.

Such additional margins will translate into increased level of toxicities specially gastrointestinal toxicities and frequent interruption of the treatment. So, to keep a balance between good coverage of the pelvic lymph nodes and toxicities, if we narrow down our extrapolation, we can calculate additional margin required for 95% of population for adequacy by adding distance equal to two times the

**Table 2:** Statistical analysis of three parameters defined in the study

| | Distance between upper portal of AP field and division of aorta | D1 after adjustment for PTV and penumbra | Distance between EIA at level of superior margin of head of femur | Difference between AP:PA width and distance between EIA at level of superior border of head of femur | D2 after adjustment for CTV to PTV and penumbra | Distance between EIA and ant. border of symphysis pubis at level of upper border of head of femur | D3 after adjustment for CTV to PTV and penumbra |
|---|---|---|---|---|---|---|---|
| N | 64 | 64 | 64 | 64 | 64 | 64 | 64 |
| Mean | 24.43 | -43.11 | -12.02 | -2.05 | 3.36 | 13.51 | -13.42 |
| Median | -23.40 | -43.30 | -13.27 | -2.09 | 3.32 | 11.85 | -15.15 |
| Std. Dev. | 11.97 | 14.95 | 6.16 | 1.25 | 1.25 | 7.66 | 7.70 |
| Minimum | 2.00 | -65.60 | -15.72 | -5.30 | 0.10 | -1.90 | -28.90 |
| Maximum | 45.60 | 22 | 16.12 | 1.79 | 7.19 | 46.90 | 19.90 |

standard deviation i.e. for D1 we need 3cm additional, for D2 additional 2.5cm and for D3, 1.5cm more. With appropriate shielding, such modification in GOG defined field seems a reasonably plausible idea.

Similaudy was conducted by Finlay et al[5] on 43 patients of cancer cervix. They used CT simulation to assess adequacy of lymph node coverage of conventional fields using bonyndmarks. Overall, 41 patients had at least 1 inadequate margin, the majority located superiorly. Twenty-four patients had at least 1 generous margin, the majority located laterally on the AP field. They concluded that, contional pelvic fields based on bony landmarks do not provide optimal lymph node coverage in a substantial proportion of patients and may include excess normal tissue in soe.

It is worthwhile mentioning that in our study we used vessels as surrogates for lymph nodes, and for precise coverage of lymph nodes we used the viewpoint of Taylor et al.[7] In their study, by using MRI with administration of iron oxide particles, they demonstrated that blood vessels with a 7mm margin offered a good surrogate target for pelvic lymph, and that was the basis of our calculation for the three defined parameters.

Similaudy was conducted by Finlay et al[5] on 43 patients of cancer cervix. They used CT simulation to assess adequacy of lymph node coverage of conventional fields using bonyndmarks. Overall, 41 patients had at least 1 inadequate margin, the majority located superiorly. Twenty-four patients had at least 1 generous margin, the majority located laterally on the AP field. They concluded that, contional pelvic fields based on bony landmarks do not provide optimal lymph node coverage in a substantial proportion of patients and may include excess normal tissue in soe.

Our results were in concordance with Pendlebury et al.[8] who studied the role of bipedal lymphangiogram in tailoring radiation portals in radical radiation therapy for Stages II or III cervix cancer. In order to cover the lymphatic channels in the pelvis in 90% of cases as outlined by the bipedal lymphangiogram, the lateral margins of the postero anterior fields would need to be 2.5 cm lateral to the pelvic brim and the anterior border of the lateral field, 0.5 cm anterior to the pubic symphysis.

A study with the same objective was done on Chinese patients by Xiang Zhang and Hua Yu et al[9] Computed tomography (CT) simulation images were used to contour pelvic vessels as substitutes for lymph nodes location. All patients had at least 1 inadequate margin, 97.0% patients had 2, and 22.0% had all the 3. The majority of the inadequate coverage were located at common iliac lymph nodes and the distal end of external iliac lymph nodes on the AP field. Authors concluded that the conventional radiation fields did not have adequate coverage of pelvic lymph nodes, and CT simulation may be a feasible technique for planning pelvic fields optimally and individually.

Bonin SR et al[6] also used lymphangiography to assess the adequacy of conventional RT field defined by GOG using bony landmarks. Ten of 22 (45%) patients would have had inadequate nodal irradiation if their fields had been designed according to standard GOG parameters. Great variability in pelvic lymph node location was demonstrated when lymphangiography is used to directly visualize their location. It was shown that bony structures were crude estimates of pelvic lymph node position.

Greer et al[10] did intraoperative retroperitoneal measurements at the time of radical surgery in 100 patients in an effort to examine the anatomic basis for field dimensions. They suggested that conventional fields frequently fail to correspond to true anatomic landmarks.

Takashi Uno et al[11] used vessel-contouring-based pelvic radiotherapy in patients with uterine cervical cancer and found traditional four-field box technique determined by bony structure contributes excellent tumor control with acceptable toxicities. However, this technique, without using individual patient's CTV, does not provide a customized treatment planning for each patient and may result in suboptimal nodal-CTV coverage.

Silvia Zunino, M.D et al[12] did anatomic study of the pelvis in carcinoma of the uterine cervix as related to the box technique and found that the high failure rate of the anterior and posterior borders of the lateral field of the "box" technique to encompass the tumor volume and its microscopic extension is in relation not just to clinical stage, but to the impact of other parameters, such as uterine flexion and associated pathology. This suggests that it is not possible to design standard borders based on conventional bone references or field size according to clinical stage and they suggested the use of sagittal MRI to use the "box" technique.

Marnitz S et al[13] evaluated location of aortic bifurcation and the subsequent common iliac lymph drainage in 42 patients with cervical cancer. The most important route of spread is the lateral drainage via the obturator to the internal and external iliac and common iliac area. The risk for common iliac lymph node metastases is increased in patients with positive pelvic or paraaortic lymph nodes. Positive common iliac lymph nodes are associated with a poorer prognosis than positive pelvic lymph nodes excluding common iliac group. The authors found that Common iliac lymph node metastases were found in up to 50% of patients with node-positive cervical cancer. The results of this study demonstrate an unsatisfactory coverage of the common iliac lymph drain by standard fields in most patients. Thus, it is required to individualize the planning target volume and to include the whole common iliac vessels according to the patient's anatomy on radiation treatment planning CT in order to improve the local control.

Three-dimensional conformal radiotherapy (3DCRT) gives significantly better PTV coverage, which may translate into better local control and survival. A comparison between conventional and conformal radiotherapy of carcinoma cervix[6,14] showed that target coverage was significantly improved with conformal plans though field sizes required were significantly larger. Doses to the OARs (rectum, urinary bladder, and small bowel) were not significantly different across the two arms. Thus, the improved delineation of the target, especially pelvic nodes, and the improved target coverage make 3DCRT an attractive tool. In a limited resource setting where CT simulator is not available, the precision in simulation can be achieved by using CECT or MRI in assessing the planning portal to ensure adequate coverage of draining lymphatics.

In the present study, we found, that the relationship between conventional pelvic fields and the location of pelvic lymph nodes in a small population of Northern Indian women was not only similar to that observed in other populations, but the inadequate coverage was even more pronounced. Notably, all the patients in our study had most of their margins inadequate. This ratio is much higher than any other studies for Western women.[5,6,13] This means that the situation of missing therapy for pelvic lymph nodes in cervical cancer patients might be much severer in Indian women. It is indispensable due to the pelvic anatomic discrepancies between occidental and oriental women.

Based on these observations, we recommend that a new pelvic radiation planning model adapting to Indian women should be founded, in which the superior border should be elevated to cover common iliac lymph nodes, and the lateral boarder should be extended to cover external iliac lymph nodes, but such attempts always translate into more toxicities.

This is the first study of its kind in the region. The study is limited by fewer patients included in the analysis, but, knowing that the variables obtained in this study are having a normal distribution, we can emphasize on the fact that even if we increase our sample size randomly from our study population there is very less likelihood of those variables to follow a different trend than what has been seen in our study group.

## 5. Conclusion

Anatomical variation is a likely possibility and therefore, pelvic fields should be planned individually. CT simulation is a feasible technique for planning pelvic fields optimally. Considering the limited resources in our setting, diagnostic CECT or MRI may be suggested to be referenced to plan pelvic fields precisely when CT simulation is not available.

## 6. Source of funding

None.

## 7. Conflict of interest

There are no conflicts of interest.

## References

1. Jemal A, Bray F, Center MM, Ferlay J, Ward E, Forman D. Global cancer statistics c.a. *Cancer J Clin*. 2011;61(2):69–90.
2. Premi HK, Gupta KB, Randhawa I. Gynaecological neoplasms in postmenopausal women of Himachal Pradesh. *J Indian Med Assoc*. 1994;92(10):326–333.
3. Negi RR, Gupta M, Kumar M. Concurrent chemoradiation in locally advanced carcinoma cervix patients. *J Cancer Res Ther*. 2010;6:159–66.
4. Perez CA, Kuske RR, Camel HM, Galakatos AE, Hederman MA, et al. Analysis of pelvic tumor control and impact on survival in carcinoma of the uterine cervix treated with radiation therapy alone. *Int J Radiat Oncol Biol Phys*. 1988;14(4):613–634.
5. Finlay MH, Ackerman I, Tirona RG, Hamilton P, Barbera L, Thomas G. Use of CT simulation for treatment of cervical cancer to assess the

adequacy of lymph node coverage of conventional pelvic fields based on bony landmarks. *Int J Radiat Oncol Biol Phys*. 2006;64:205–214.
6. R BS, Lanciano RM, Corn BW, Hogan WM, Hartz WH, E HG. Bony landmarks are not an adequate substitute for lymphangiography in defining pelvic lymph node location for the treatment of cervical cancer with radiotherapy. *Int J Radiat Oncol Biol Phys*. 1996;34(1):167–72.
7. Taylor A, Rockall AG, Reznek RH, Powell ME. Mapping pelvic lymph nodes: guidelines for delineation in intensity modulated radiotherapy. *Int J Radiat Oncol Biol Phys*. 2005;63(5):1604–1612.
8. Pendlebury SC, Cahill S, Crandon AJ, Bull CA. Role of bipedal lymphangiogram in radiation treatment planning for cervix cancer. *Int J Radiat Oncol Biol Phys*. 1993;27(4):959–62.
9. Zhang X, Yu H. Evaluation of pelvic lymph node coverage of conventional radiotherapy fields based on bony landmarks in Chinese cervical cancer patients using CT simulation. *J Zhejiang Univ Sci B*. 2009;10(9):683–688.
10. Greer BE, Koh WJ, Figge DC, Russell AH, Cain JM, Tamimi HK. Gynecologic radiotherapy fields defined by intraoperative measurements. *Gynecol Oncol*. 1990;38(3):421–424.
11. Uno T, Isobe K, Ueno N, Kobayashi H, Sanayama Y, Mitsuhashi A. Vessel-contouring-based Pelvic Radiotherapy in Patients with Uterine Cervical Cancer. *Japanese Journal of Clinical Oncology*. 2009;39(6):376–380.
12. Zunino S, Rosato O, Lucino S, Jauregui E, Rossi L, Venencia D. Anatomic study of the pelvis in carcinoma of the uterine cervix as related to the box technique. *Int J Radiat Oncol Biol Phys*. 1999;44(1):53–59.
13. Marnitz S, Khler C, Schneider A. Interindividual variability of lymph drainages in patients with cervical cancer. Implication on irradiation planning. *Strahlenther Onkol*. 2006;185:80–85.
14. Goswami J, Patra NB, Sarkar B, Basu A, Pal S. Dosimetric comparison between conventional and conformal radiotherapy for carcinoma cervix: Are we treating the right volumes? *South Asian J Cancer*. 2013;2:128–131.

## Author biography

**Deepak Tuli** Senior Resident

**Purnima Thakur** Senior Resident

**Manoj Gupta** Professor

**Rajeev K Seam** Professor

**Manish Gupta** Professor

**Cite this article:** Tuli D, Thakur P, Gupta M, Seam RK, Gupta M. Evaluation of adequacy of conventional radiotherapy fields based on bony landmarks in cervical cancer patients using contrast enhanced computed tomography scan- A regional cancer centre experience. *Indian J Obstet Gynecol Res* 2019;6(3):302-307.