Importance of Aortic Bifurcation for Pelvic Radiotherapy in Cervical Cancer Patients

Deepa Gautam[1], Sweta Baral[2], Nitu Sharma[3]

1. Registrar, Department Of Radiation Oncology, B.P. Koirala Memorial Cancer Hospital , Bharatpur, Nepal. 2. Department Of Radiation Oncology, Bhaktapur Cancer Hospital, Bhaktapur. 3. Department Of Radiology, B.P. Koirala Memorial Cancer Hospital , Bharatpur, Nepal.

Abstract

Purpose: Radiotherapy is a major modality for treating cervical cancer patients. Conventionally, superior border of treatment portal in cervical cancer is kept at L4-L5 intervertebral spaces; however, newer concepts suggest that aortic bifurcation should be the determining factor for the superior border. This study aims to observe the level of aortic bifurcation in cervical cancer patients.

Methods and materials: A retrospective observational study was conducted in cervical cancer patients undergoing radiotherapy between July 2019 and August 2020 in B.P. Koirala Memorial Cancer Hospital, Bharatpur. Histologically confirmed International Federation of Gynecology and Obstetrics (FIGO) stages II and III carcinoma cervix patients referred for radiation therapy were included in the study. Baseline variables including age group, FIGO stages were noted from the hospital record. Computed Tomography (CT) simulation images were reviewed from the treatment planning system to detect the levels of aortic bifurcations.

Results: Total 281 patients of carcinoma cervix were registered for the study with age ranging from 29 years to 87 years and the commonest age group being 51-60. The maximum patients were of stage IIB (46.6%). The aortic bifurcations levels varied from mid L3 to L5-S1 intervertebral space and the commonest level observed was mid L4 vertebra in 70 (24.9%) patients.

Corresponding Author:
Dr Deepa Gautam. Registrar, Department Of Radiation OncologyB.P. Koirala Memorial Cancer Hospital, Bharatpur, Nepal. Phone number: 00977-9846306434, Email: gautamdeepa09@yahoo.com

Conclusion: Anatomical variation in the level of aortic bifurcation, considered as the superior CTV border in pelvic radiotherapy in cervical cancer, demands the conventional superior border, L4-L5 intervertebral space, to be shifted more superior to include common iliac nodes in the treatment field.

Key words: aortic bifurcation, carcinoma cervix, pelvic radiotherapy

Introduction:

Globally, cervical cancer accounts for over half a million of new cases annually.[1] In Nepal, it is still the commonest cancers among females and over 2,000 new cases of cervical cancer are reported each year.[2] Radiotherapy, a combination of external beam radiotherapy and brachytherapy has been the standard of treatment for cervical cancer.[3] Although relentless advancements in external beam radiotherapy delivering techniques for carcinoma cervix in the form three dimensional-conformal radiotherapy, intensity-modulated radiotherapy, volumetric-modulated arc therapy, have been made, in the developing countries like ours where patient burden is high but health resourced are limited, two dimensional conventional treatment modalities are still in use for treating those patients.

The conventional Anterio-posterior (AP)-posterio-anterior (PA) parallel-opposed fields or AP-PA fields with two additional lateral fields (four-field box techniques) are used for delivering pelvic radiotherapy.[3] The aim of pelvic radiotherapy in such patients is to cover the main tumor bulk in cervix and its local extensions, and regional pelvic lymph nodes which include common iliac, external and internal iliac, obturator, and presacral nodes.[3] The traditional superior border of the pelvic field lies at the level of L4-L5 intervertebral space. However, the newer consensus guidelines for conformal radiotherapy have come with the concept of aortic bifurcation being used as the superior clinical target volume (CTV) for pelvic radiotherapy in cervical cancer patients and it is also reported from the past studies that there is an individual variation in the level of aortic bifurcation.[4,5,6]This study aims to observe the level of aortic bifurcation in cervical cancer patients receiving radiotherapy among Nepalese population.

Materials and methods

A hospital-based retrospective observational study was conducted in patients of cervical cancer undergoing radiotherapy between July 2019 and August 2020 in the department of Radiation Oncology at B.P. Koirala Memorial Cancer Hospital, Bharatpur, Nepal after taking ethical clearance from Institutional Review Committee (IRC). Patients of histologically confirmed carcinoma cervix International Federation of Gynecology and Obstetrics (FIGO) Stage II and III with radiologically negative lymph nodes referred for radiation therapy were eligible for the study. Baseline variables including age group, FIGO stages were retrieved from hospital record. Computed Tomography (CT) simulation axial sections of 3mm thickness extending from T12-L1 to mid-thigh which were utilized for conventional treatment planning were reviewed retrospectively from the treatment planning system. The vertebral levels of aortic bifurcations were then recorded separately for each case by determining the bifurcation in axial sections and then correlating the vertebral levels in sagittal sections.

Results

A total of 281 patients of carcinoma cervix were registered for the study. The age of the patients ranged from 29 years to 87 years with the commonest age group ranging between 51 years and 60 years. [Table 1] The maximum number of patients belonged to FIGO stage IIB (46.6%). [Table 1] The levels of aortic bifurcations varied from mid L3 to L5-S1 intervertebral space and the commonest level of aortic bifurcation was observed at mid L4 vertebra in 70 (24.9%) patients. [Table 2 and Figure 1]

Discussion

The present study was conducted to find out the vertebral level of aortic bifurcation among 281 patients receiving pelvic radiotherapy for cervical cancer. There was a great variation in the level of division of abdominal aorta into right and left common iliac branches and the most common being body of L4 vertebrae especially at the mid-level.

Majority of the previous studies have demonstrated similar results that the abdominal aorta divides at the level of body of L4 vertebra in most of the patients; however, the upper, mid and lower level at the L4 vertebral body had differed. [7,8,9,10]

Table 1: Baseline Variables

Age groups in years	Number (%)
21-30	3(1.1)
31-40	30(10.7)
41-50	78(27.8)
51-60	86(30.6)
61-70	62(22)
71-80	20(7.1)
81-90	2(0.7)
Total	281(100)
FIGO stage	
IIA	76 (27)
IIB	131 (46.6)
IIIA	30 (10.7)
IIIB	44 (15.7)

Table 2: Vertebral level of aortic bifurcation

Vertebral level	Number (%)
L3 mid	3(1.1)
L3 lower	7(2.5)
L3-L4 junction	25(8.9)
L4 upper	46(16.4)
L4 mid	70(24.9)
L4 lower	58(20.6)
L4-L5 junction	59(21)
L5 upper	8(2.8)
L5 mid	4(1.4)
L5-S1	1(0.4)
Total	281(100)

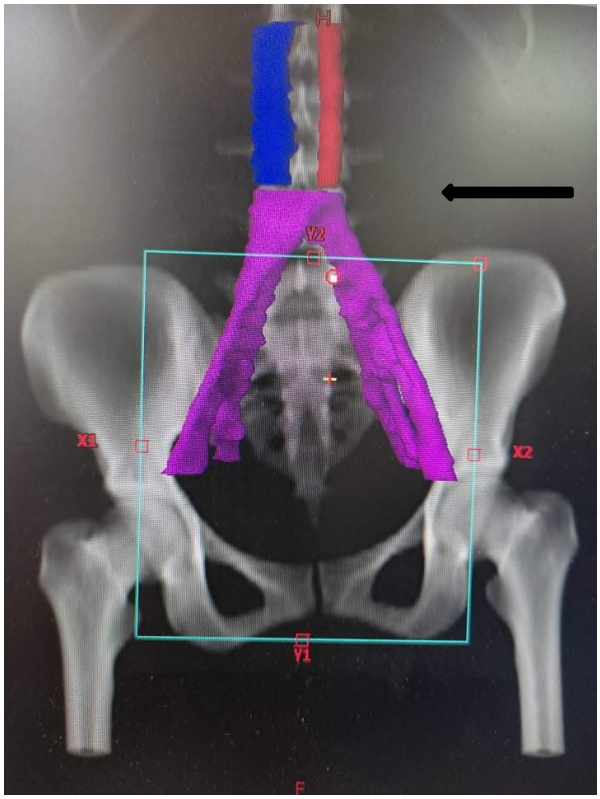

Figure 1: Contoured abdominal aorta (red), Inferior Venacava (blue), arrow mark denotes the bifurcation level, common iliac vessel and branches (magenta), conventional AP treatment portal (cyan) with superior border at L4-L5 intervertebral space.

On the contrary, a study by Ponni et al. in 26 cervical cancer patients demonstrated that over half (53.84%) of the patients had aortic

bifurcation at the level of L3-L4 intervertebral space.[7] With regard to the aortic bifurcation at L3-L4 junction, the present study depicted the finding in just 8.9% of patients and this ranged from 5.2% to 16.6% of patients in similar previous studies. [9,10]

In the present study, aortic bifurcation occurred above L4-L5 junction in 74.4% of patients similar with the observation by Mishra et al. while Ponni et al. and Kaushal et al. noted in higher number of patients, 84.6% and 81.3% of cases respectively.[7,8] In a study of 116 patients by Rai et al., it was found that over half(55.3%) of the patients had aortic bifurcation in front of the body of L4 vertebra and nearly three-fourth(70.7%) had the bifurcation being excluded by the superior pelvic field border which correlated with the nodal recurrences they observed in their study. [9]

We recorded aortic bifurcation at the level of L4-L5 intervertebral space in 21% of the patients. Mishra et al. observed that one-fourth (25.6%) of the patients among 90 had aortic bifurcation at the level of L4-L5 intervertebral space and approximately half of them had bifurcation at the level of body of the L4 vertebra while Kaushal et al., in their study of 64 patients, had noted the bifurcation at the same level in 15.6% of patients. [9,10]

There is anatomical variation in the level of aortic bifurcation which is the superior CTV border in pelvic radiotherapy while treating cervical cancer patients [5,6] and hence, L4-L5 intervertebral space, which is the superior border for 2D-conventional pelvic field [3], may not always correlate with the aortic bifurcation to cover the pelvic lymph nodes especially the common iliac lymph nodes.

Although, ideally, conformal radiotherapy with individually customized fields should be the technique of choice, in the institutions treating a large patient volume with limited resources with conventional modalities, a consideration for modification in the superior border would be beneficial.

Conclusion

The level of abdominal aorta division ranged from mid L3 vertebra to L5-S1 intervertebral space and majority of bifurcation occurred above L4-L5 intervertebral space in the studied patients. Using the conventional superior border might not approximately irradiate the common iliac group of lymph nodes to the adequate dose. Hence, the pelvic

radiotherapy treatment portal should be individualized with the help of CT simulator based planning, and even in cancer institutes where CT simulator is not available, the traditional superior border needs to be shifted more superior.

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