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"A Study on Dose Distribution Variations Between Single Direct PA Field With Standard (4cm) Depth And Single Direct PA Field with ICRU Prescribed Depth in The Treatment ofThoracic Spinal Metastasis."

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***Abstract*:** *Backache is the main symptom in the spinal bone metastasis of cancer and it requires Radiotherapy as pain relieving procedure as well as to stabilize the bone. About 70% of symptomatic lesions are found in the Thoracic spine. In Cancers like breast , myeloma, prostate, thyroid and lymphoma where in patients live longer life, RT can be useful in prevention and pain relief. Hence involved bones should be treat as early as possible to prevent the morbidity. Most of the centers amongst conventional cancer treatment setups it has been in common practice to use standard depths(empirical) in single direct PA manual planning to calculate treatment units depending upon area of the spine involved like cervical vertebrae-3cm depth ,thoracic vertebrae 4-5cm depth, lumbar spine 5-7cm depth depending upon patients built(standard depth plan). And also there is no consensus in literature exactly where to prescribe the dose in vertebrae for single direct conventional planning in spinal metastases. As per recommendations of ICRU for single direct PA planning to spinal metastasis, centre of the vertebrae will be consider as a point of depth for prescribing the dose(ICRU plan).There was better dose distribution coverage in the ICRU plan than standard depth plan. Even then ICRU plan dose distribution coverage was not met the treated volume criteria of ICRU. Hence it may be advisable to opt other planning techniques which give good dose distribution in the target volume in spinal bone metastasis.*

***Key words**: single direct plan, dose, icru, depth.radiotherapy.*

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I. Introduction

Backache is the main symptom in the spinal bone metastasis of cancer and it requires Radiotherapy as pain relieving procedure as well as to stabilize the bone. About 70% of symptomatic lesions are found in the Thoracic spine. InCancers like breast , myeloma, prostate,thyroid and lymphoma where in patients live longer life,RT can be useful in prevention and pain relief. Hence involved bones should be treat as early as possible to prevent the morbidity. In adjuvant with good quality care and chemotherapy agents it can gives good quality and longer survival period. [1,2,3,4]. Irrespective of the survival time, Most of these patients will often require active treatment because of pain and other associated problems and general deterioration of quality of life [1].

In Bone-only metastases, and good performance status with a longer life expectancy, a longer course of treatment (30 Gy in 10 fractions) may be more appropriate to minimize the risk of retreatment. As per ICRU report 50(International commission on Radiation Units and Measurements) the treated volume , it is the volume enclosed by an isodose surface that is selected and specified to achieve purpose of treatment ,usually taken as the volume enclosed by 95% isodosecurve.It can be achieved in 3D planning and other conformal treatment options with good therapeutic ratio[1,2,3,4,5].

60-70% of radiotherapy treatment centers in the developing world are still depends on conventional 2D planning methods and delivering the treatment with cobalt 60 machines and simple Linac Machines even without x-ray simulators and other supportive systems with limited resources.As per general guidelines of ICRU for radiotherapy, the center of the target volume will be consider as a reference point but in single direct PA fields in thorax and lumbar vertebral metastases the center of the target volume is situated near or within the spinal canal where the proper bony structure is not present hence the center of the vertebral body taken as prescribed point of depth in ICRU depth plan (ICRU reference point) as per ICRU recommendations[5].Because of limited resources and workload it may be practically difficult to measure the exact depth for single direct fields in spinal metastasis, And also there is no consensus in literature exactly where to prescribe the dose in vertebrae for single direct conventional planning in spinal metastases. Hence in

most of the centers amongst conventional cancer treatment setups it has been in common practice to use standard depths(empirical) in manual planning to calculate treatment units depending upon area of the spine involved like cervical vertebrae-3cm depth ,thoracic vertebrae 4-5cm depth, lumbar spine 5-7cm depth depending upon patients built[2]. Though some Radiation oncologists prefer AP-PA fields to spinal metastasis but most of the practitioners prefer single direct field for spinal metastasis. since there are less studies on dose distribution verses benefit especially in palliative 2D planning, the importance of depth and dose distribution is less emphasized in radiotherapy of spinal metastasis[6,7,8,9]. With this back ground our aim of study is to emphasize the dose distribution variations in two types of single direct PA plans , one with standard depth(4cm) and another with ICRU prescribed reference point.

II. Material And Method

Thoracic spine images of CT simulation were collected from randomly chosen 20 cancer patients and utilized for this virtual planning. In each patient 4-5 vertebrae were contoured as Target volume1 and vertebral bodies contoured as Target volume 2 since it is most important part involved in fractures and cord compressions.Single direct PA field created with 5mm margin on either side of vertebrae and up to intervertebral discs as upper and lower margins of field.Treatment MUs were calculated in ARYA 2D planning system with help of field sizes at different depths in SSD, 300/# schedule with 6MV energy. for each patient MUs were calculated for two different depths in thorax like 4cm as standard (empirical)practicing depths and for ICRU depth separately . field size and MUs were entered in 3D planning system for each depth and doses calculated separately in SSD without any changes, likewise Comparative virtual plans were generated with the help of 3D images and 3D planning system. 2 virtual plans were generated for each patient and total 40 plans were generated. Dose coverage observed and noted. the center of the vertebral body was taken as ICRU plan depth(ICRU reference point) and measured from posterior skin surface.[5,7].Cumulative dose volume histograms(DVH) were generated for each plan .Minimum, maximum and mean doses and percentage of area covered by >90% of given doses in target volume1 and target volume2 were collected in both thoracic spine plans.

III. Results

Twotypes of plans in single direct posterior fields and their dose distribution in target volume1 of thoracic spine are shown in table 1 and since the vertebral body-target volume2 is the key part in the vertebrae its doses coverage is shown in table 2. Percentage of vertebral body volume covered by >90% given dose shown in table.3 Dose distribution in target volume was better in PA field with ICRUdepth(depth at centre of vertebrae) than the other single direct posterior field plan. minimum ,maximum and mean doses were higher in ICRU depth fields plans .

Table.1.The Mean percentage of minimum, maximum and mean of target volume 1(total vertebrae) doses ±standard deviation for all plans of thoracic spine of 20patients.

1.Mean dose (range) %± SD in Thoracic spine(target volume 1)			
		At 4cm depth	ICRU depth
1	Minimum	73.7 (67-79.1) ±3.8	79.1 (54.4-89.9) ±9.3
2	Maximum	112.4 (101-117) ±3.9	126.6 (120-139.5) ±5.2
3	Means	93.1 (85.8-97.7) ±3.7	105.5 (95.6-116.1) ±4.3

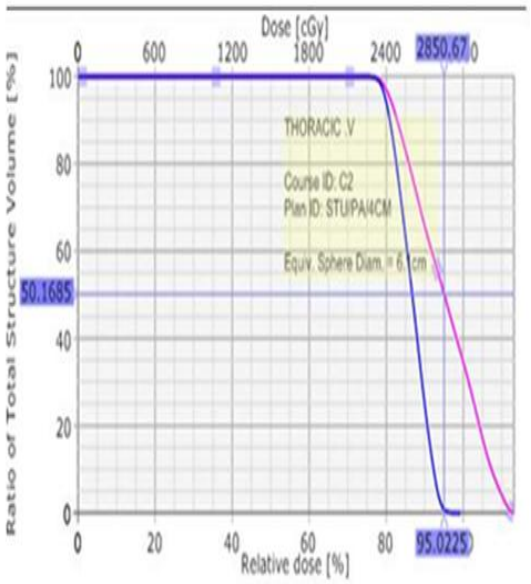
Table.2.The Mean percentage of minimum, maximum and mean of target volume2 (vertebral body) doses ±standard deviation for all plans of thoracic spine of 20 patients.

2.Mean dose (range) %± SD in Thoracic spine(target volume 2)			
		At 4cm depth	ICRU depth
1	Minimum	73.75 65.4-79 4.07	82.8 74.5-90 3.77
2	Maximum	98.5 89.2-103.9 3.93	110.5 102.6-121.9 4.4
3	Means	86.6 78.7-91.2 3.6	97.3 88.3-106 3.6

Table.3 Percentage of vertebral body(target volume 2) area covered by >90% of prescribed dose in thoracic spine of 20 patients.

percentage of vertebral body(target volume 2) area covered by >90% of prescribed dose in Thoracic spine			
	Thoracic spine	At 4cm depth	ICRU depth
1	Mean	29.87%	88.75
2	Min-Max	0-58%	38-100
3	SD	18.92	15.43

4CM DEPTH



4CM DVH

Fig.1.Dose distribution at 4cm depth plan**Fig.2.** Dose volume histogram for 4cm depth plan

ICRU DEPTH

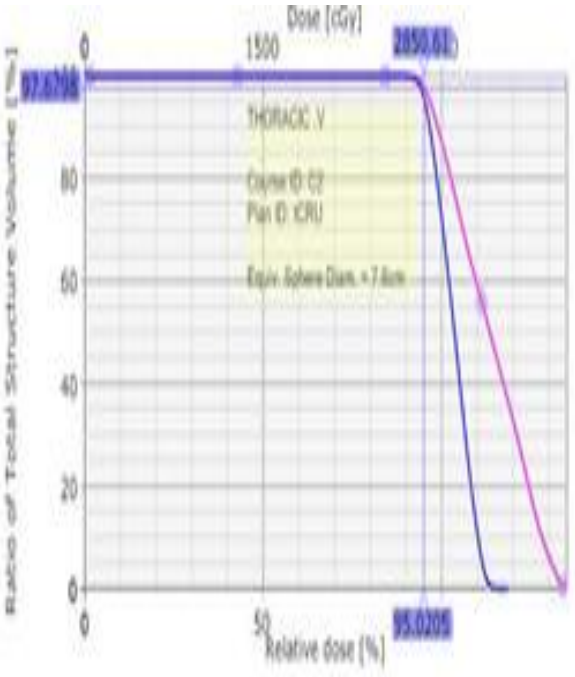


Fig.3 Dose coverage in ICRU depth plan**Fig.4**. Dose volume Histogram in ICRU depth plan

IV. Discussion

In spinal bone metastasis, Radiotherapy is the main stay of treatment for pain relief and to prevent fractures and progression of early lesions.[1].The homogenous dose distribution in target volume plays significant role in treatment outcome . factors like depth, photon energy, field size ,portals mainly determines the dose distribution variations.. As per ICRU report, homogeneous dose within 95% to 107% of the prescribeddose is recommended for the target volume[5].avariationof ± 10% from the prescribed dose is widely used inclinical practice and was used in the present study.In this study we collected data on the dose distribution variations at different depths which are being in practice for single direct PA manual planning for spinal bone metastasis on cobalt and 6mv machines, we also[4].verified and compared the dose outcomes withinthesetwosingle direct posterior field plans.

Dose distribution was improved in ICRU reference point depth plan than standard depth (4cm) single direct field plan. In target volume1(total vertebrae)mean percentage of mean dose was105.5%(95.6-116.1)±4.3 but its mean percentage of maximum dose is126.6 and ranges from minimum120 to maximum139.5%±5.2 which is more than the other plan and its >90% dose coverage area in target volume 2(vertebral body) mean is 88.75%. In contrast , the percentage of area which is covered by >90% dose in the vertebral body which is the key part in the vertebrae for fractures and card compression is 29.87% (0-58%)low and suboptimal in other 4cm depth PA plan. . Our results were comparable with study done by FundagulandicTurkey(ref) . According to their study single direct fields with reference dose to IBCRp , / ICRUp points did not achieve the ICRU Report 50 recommendations for PTV dose distribution . But dose distribution is improved when compared to single direct PA field panning with standard (4cm) depth. the doseheterogencity and maximum doses were observed as if it was observed in other studies[7].the maximum doses were high but they are within normal tissue tolerance range at palliative doses.

V. Conclusion

Homogenous dose distribution with in the target volume is the prerequisite to achieve optimum response from Radiotherapy treatment.since depth plays a detrimental role in dose distribution , measuring the depth is essential in single direct 2D manual plans for spinal metastasis . As per our study even dose prescribing at a depth of mid thoracic vertebrae was also not met the recommendations of ICRU reporthence it may be advisable to opt other planning techniques which gives good dose distribution in the target volume in spinal bone metastasis.

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