IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 15, Issue 6 Ver. V (June. 2016), PP 75-78
www.iosrjournals.org

TPS Evaluation & Dosimetric Comparison of AAA and PBC Treatment Planning Algorithms for Sliding Window and Multi Static Segmented MLC IMRT Deliveries to the Carcinoma Esophagus

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I. Introduction

Radiation therapy is commonly applied to the cancerous tumor because of its ability to control abnormal cell growth also radiotherapy used to prevent tumor recurrence after surgery. Nowadays radiation is widely used for a variety of medical, scientific, and industrial purposes; of course we can say the Radiation is part of our daily life. In the Radiation therapy ionizing radiations are being commonly used to control, destroy the malignant cells. The healthy normal cells surround the tumors also may get side effect due to in correct dose calculation and delivery, these side effects may be more serious, so there should be basic and enough knowledge to the personal about radiotherapy planning related dose calculations and concerns.

The recent sophisticated advanced technologies have revolutionize the planning and delivery of radiation therapy with the help of Enhanced Dynamic Wedge (EDW), Multi-leaf collimator (MLC), FFF (Flattening Filter Free) .The non uniform flounce of radiation can be generated across the fields with the help of MLC's and same can be delivered in intensity modulated radiation therapy (IMRT), Volumetric Arc Therapy (VMAT), Image guided radiation therapy (IGRT) and in Gating Radiotherapy.

To Treat the carcinoma Esophagus patients ,lot of Homogeneity and heterogeneity factors have been involved due to body curvature and Lung ,so that the Treatment Planning System Softwares are taking major role in radiotherapy in order to achieve the good tumor control; there are number of algorithms to better dose calculation with accounting so many necessity factors.

Treatment planning algorithms such as Pencil Beam Convolution (PBC) Anisotropic Analytical Algorithm (AAA) had been widely used for dose calculations and still too.

The PBC based calculations were documented poor performs in calculating dose to tumors in and around the Esophagus lungs. It does its calculations of dose distributions along a ray of line from pencil beam source (To account for differences in attenuation there are corrections to each pencil beam that are obtained by a correction factor. These corrections are done in terms of calculation with respect to a point. The dose from the adjacent pencil beams is left out in the calculation leading to inconsistencies in dose determination of large tumors in homogeneity.

The development of a superposition-convolution method known as AAA has been shown to be more than accurate than PBC in photon dose calculations. Because the AAA algorithm takes into account lateral scattering it calculates photon beams interactions in regions of complex tissue heterogeneities better. These both algorithms have been installed in our hospital for the 3D-planning and IMRT Planning. In this study our aim is to treatment planning evaluation & Dosimetric comparison of Anisotropic Analytical Algorithm (AAA) and Pencil Beam Convolution Algorithm (PBC) for Sliding window (SW) and Multi Static Segmented (MSS) IMRT deliveries to the Cancer of Middle esophagus cancer patients who were treated within the period of January 2012, to April 2016.

II. Material & Methods

Patient: Department radiotherapy, GSL Medical College& Trust Cancer Hospital servicing the better treatment for cancer Patients in and around Andhra Pradesh since 1995, our department works in close collaboration with the departments of surgery, medical oncology, Radiation Oncology, Radiology, General Medicine ,etc…

CT Simulation: The CT scanner used for simulation was a Toshiba, Multi slice CT scanner. Slice thickness was 5 mm. Scans were obtained from the cricoids cartilage to the superior aspect of the L1 vertebra. Patients were positioned supine with arms immobilized above the head and their legs on a knee support.

Contouring & TPS Planning: As per International Commission on Radiation Units and Measurements (ICRU) recommendations, tumor were taken into account by adding security margin (internal margin) around the clinical target volume (CTV),then Positioning uncertainties are then added to create the planning target volume (PTV). However, this strategy has its own limits. For tumors with significant motion, such as those in and around the Thorax, diaphragms require additional safer treatment margins due to respiration.

In our Study each patients was planned by seven gantry angles (0°,50°,100°,140°,220°,260°,310°) with two different Algorithms (AAA & PBC) for two different MLC deliveries . For Each patient four Set of Plans was created as 1.AAA_MSS 2.AAA_SW 3.PBC_AAA 4. PBC_SW

Each Patient was planned to deliver 50.4Gy in 28 fractions. To ensure the good conformity and Homogeneity index for each Patient, the better IMRT plan was created by AAA algorithm with MSS Delivery. Also surrounding critical organ doses considered as per RTOG guidelines. Again the Plan was recalculated to AAA algorithm with SW delivery, PBC with MSS Delivery, PBC with SW Delivery with the same retaining identical Beam arrangements. while meeting the same normal tissue constraints, the plans were compared based on dose conformity index, dose homogeneity index, Maximum and average dose to surrounding normal structures (Lt Side Lung,Rt side Lung, Spinal Card and heart were analyzed.

III. Result & Discussion

The 95% of PTV Target volume coverage and normal tissues dosage were analyzed; the Plan which was created by AAA with MSS (AAA_MSS) was taken as primary plan. The Homogeneity Index and Conformity index in these Plans is (1.05±.02, 1.0±0.06).When the Plan recalculated with AAA with SW (AAA_SW) the Homogeneity Index and Conformity index were (1.04±.015, 1.02±0.08). In this plan the 95% of target is receives

Little higher dose (25cGy±20cGy) than AAA_MSS but the V20 of Lt Lung, Rt Lungs, heart and spinal card receives 0.3% ± 0.2% higher dose than AAA_MSS.

Again the primary plan was recalculated by PBC with MSS(PBC_MSS) .The Homogeneity Index and Conformity index in these Plans were (1.02±.02, 0.80±0.1).in these Plans the 95% of target is receives lesser dose(~1.5Gy) than AAA_MSS. then the plan was recalculated by PBC with SW(PBC_SW). The Homogeneity Index and Conformity index in these Plans is (1.01±.01, 0.80±0.1) but in these PBC Algorithm calculated Plans V20 of Lt Lung, Rt Lungs, heart and spinal card receives 2.0 to 3% higher dose than AAA_MSS.

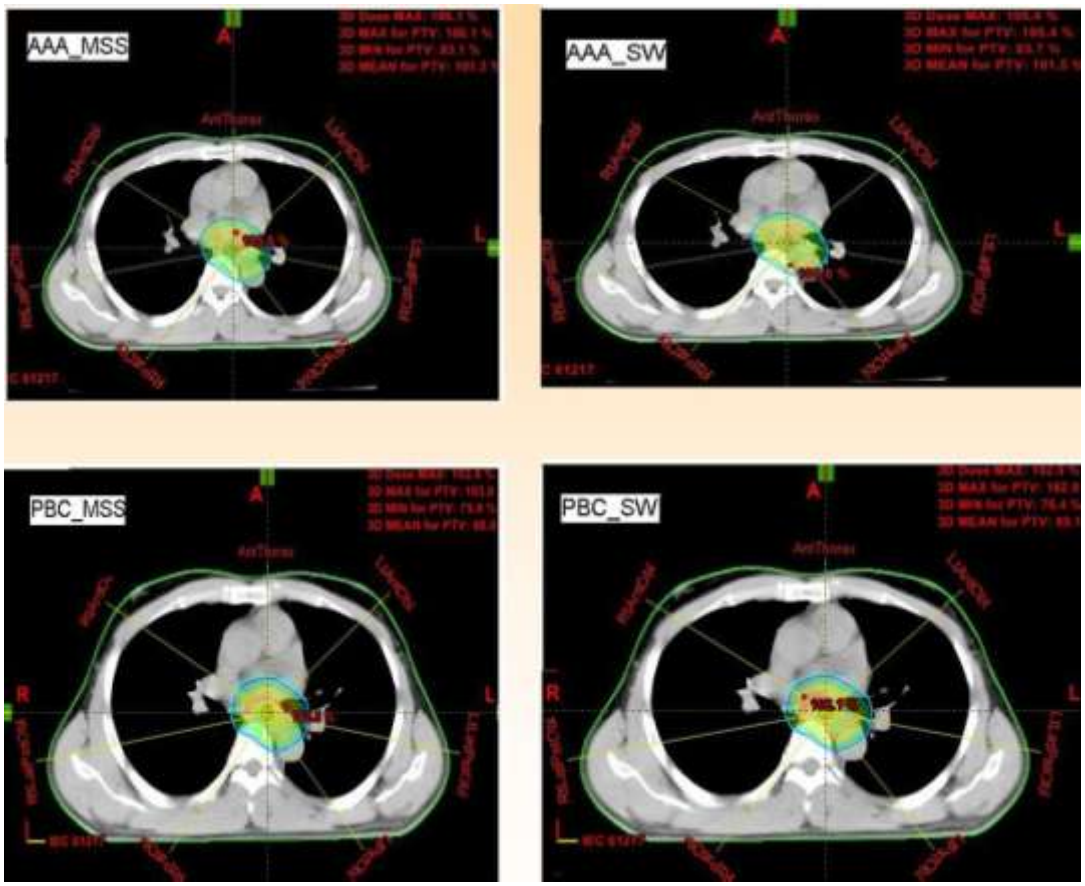

Fig 1: Showing the Dose Color Wash of Different Plans

Patient	Technique	95% of Target Dose(Gy) /50.4Gy	Patient	Technique	95% of Target Dose(Gy) /50.4Gy	Patient	Technique	95% of Target Dose(Gy) /50.4Gy
P1	AAA_MSS	47.61	P11	AAA_MSS	47.16	P21	AAA_MSS	48.46
	AAA_SW	47.77		AAA_SW	47.22		AAA_SW	46.47
	PBC_MSS	45.96		PBC_MSS	45.85		PBC_MSS	46.28
	PBC_SW	46.1		PBC_SW	46.90		PBC_SW	47.19
P2	AAA_MSS	48.53	P12	AAA_MSS	47.18	P21	AAA_MSS	48.22
	AAA_SW	48.76		AAA_SW	47.32		AAA_SW	48.40
	PBC_MSS	46.82		PBC_MSS	45.83		PBC_MSS	45.85
	PBC_SW	47.02		PBC_SW	45.86		PBC_SW	45.96
P3	AAA_MSS	48.91	P13	AAA_MSS	47.69	P23	AAA_MSS	48.90
	AAA_SW	49.06		AAA_SW	48.08		AAA_SW	49.10
	PBC_MSS	45.33		PBC_MSS	45.0		PBC_MSS	45.23
	PBC_SW	45.52		PBC_SW	45.20		PBC_SW	45.55
P4	AAA_MSS	48.06	P14	AAA_MSS	46.59	P24	AAA_MSS	48.90
	AAA_SW	48.32		AAA_SW	46.75		AAA_SW	49.09
	PBC_MSS	46.25		PBC_MSS	46.93		PBC_MSS	45.35
	PBC_SW	46.56		PBC_SW	45.1		PBC_SW	45.55
P5	AAA_MSS	47.18	P15	AAA_MSS	48.26	P25	AAA_MSS	48.55
	AAA_SW	47.32		AAA_SW	48.42		AAA_SW	48.45
	PBC_MSS	45.83		PBC_MSS	46.45		PBC_MSS	46.40
	PBC_SW	45.86		PBC_SW	46.25		PBC_SW	46.20
P6	AAA_MSS	46.86	P16	AAA_MSS	48.25	P26	AAA_MSS	47.18
	AAA_SW	46.97		AAA_SW	48.44		AAA_SW	47.32
	PBC_MSS	45.63		PBC_MSS	45.81		PBC_MSS	45.83
	PBC_SW	45.66		PBC_SW	45.98		PBC_SW	45.86
P7	AAA_MSS	47.79	P17	AAA_MSS	47.58	P27	AAA_MSS	47.79
	AAA_SW	48.08		AAA_SW	47.40		AAA_SW	48.08
	PBC_MSS	45.3		PBC_MSS	45.71		PBC_MSS	45.3
	PBC_SW	45.40		PBC_SW	45.76		PBC_SW	45.40
P8	AAA_MSS	46.10	P18	AAA_MSS	46.86	P28	AAA_MSS	46.59
	AAA_SW	46.29		AAA_SW	46.97		AAA_SW	46.75
	PBC_MSS	46.0		PBC_MSS	45.63		PBC_MSS	46.93
	PBC_SW	46.02		PBC_SW	45.66		PBC_SW	45.1
P9	AAA_MSS	48.35	P19	AAA_MSS	48.06	P29	AAA_MSS	47.79
	AAA_SW	48.44		AAA_SW	48.32		AAA_SW	48.08
	PBC_MSS	45.91		PBC_MSS	46.25		PBC_MSS	45.3
	PBC_SW	45.91		PBC_SW	46.56		PBC_SW	45.40
P10	AAA_MSS	48.03	P20	AAA_MSS	47.75	P30	AAA_MSS	47.58
	AAA_SW	47.62		AAA_SW	48.5		AAA_SW	47.40
	PBC_MSS	46.04		PBC_MSS	45.50		PBC_MSS	45.71
	PBC_SW	46.0		PBC_SW	45.40		PBC_SW	45.76

Table 1: Shows 95% PTV Volume Coverage Dose/ 50.4Gy

IV. Conclusion

Several studies have shown that in conventional 3-D planning AAA calculates dose distributions in a heterogeneous medium more accurately than PBC.also studies were able to demonstrate an over-production of the dose to the lung portion of the phantom for AAA calculations.

In our study results we are conforming the discrepancy between the AAA and PBC algorithms for both Sliding window (SW) and Multi Static Segmented (MSS) IMRT deliveries. The 95% volume of PTV in the AAA_SW plans is getting better Coverage than the other plans. 95% of PTV Volume in AAA_SW receives maximum 0.5% higher than AAA_MSS plans and 7% higher than PBC_MSS, PBC_SW plans.

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