

Radiation Therapy using Simultaneous Integrated Boost Technique for Head and Neck Cancer

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ABSTRACT: Purpose/Objectives: comparison the results between standard dose 2Gy/fraction technique and simultaneous integrated boost (SIB) with 2.2Gy/fraction technique.

Materials/Methods: use Eclipse 13 software to do the treatment planning for head and neck cancer patients by two methods:

- Simultaneous integrated boost radiation therapy with 3 different doses 2.2Gy/fraction for primary tumor and clinical nodes, 2Gy/fraction for high risk nodes and 1.8Gy/fraction for low risk nodes.
- Radiation therapy with 2Gy standard doses, including three stages namely stage I with 50Gy to target volume and high risk nodes; stage II with 10Gy boost to target volume and stage III with 10Gy boost to the target volume.

Results: there is no significant difference in dose of both the target volume and OARs (Organ at risk). However, simultaneous integrated boost radiation therapy is performed with on a treatment plan, the control of the treatment planning will be better than standard dose 2Gy/fraction technique in process of planning and controlling QA. With the SIB technique, the treatment time will be decreased.

KEYWORDS: head and neck cancers, simultaneous integrated boost, inverse planning, intensity modulated radiation therapy.

I. INTRODUCTION

Since October 2015, the Oncology Hospital has begun applying intensity modulated radiation therapy to treat cancer patients. Head and neck cancer is planned for beams with prescribed dose of 70Gy including standard dose 2Gy, so patients undergo treatment for 35 times with radiation therapy. However, if we use simultaneous integrated boost radiation therapy with 2.2Gy/fraction for primary tumor and clinical nodes, patients need only about 30 times of treatment with radiotherapy.

In this work, we would like to compare the results between standard dose 2Gy/fraction technique and simultaneous integrated boost in 2.2Gy/fraction.

SIB-IMRT treatment is planned for a large irradiation and this technique allows the simultaneous delivery of different dose levels to different target volumes within a single fraction. [1]

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Target/Structure	Quantity	Conventional 3DCRT	SIB			
			SIB1	SIB2	SIB3	SIB RTOG
PTV1	NTD (Gy)	50	50	—	—	—
	ND (Gy)	50/54	54	—	—	—
	Fractions	25/30	30	—	—	—
	Dose/f(Gy)	2.0/1.8	1.8	—	—	—
PTV2	NTD (Gy)	60	60	—	—	—
	ND (Gy)	60	60	—	—	—
	Fractions	30	30	—	—	—
	Dose/(Gy)	2	2	—	—	—
PTV3	NTD (Gy)	70	74.4	78.4	84.4	70
	ND (Gy)	70	68.1	70.8	73.8	66
	Fractions	35	30	—	—	—
	Dose/f(Gy)	2	2.27	2.36	2.46	2.2
Bone	NTD (Gy)	70	74.6	79.7	85.7	70.4
Muscle	NTD (Gy)	70	71.7	75.8	80.5	68.4
Mucosa	NTD (Gy)	70	69.6	72.9	76.6	67

Table1: The prescription dose of SIB treatment

Table 1 is the comparison of SIB –IMRT and conventional IMRT treatment plans at different doses to PTV (planned target volume) and health organ stick to GTV (gross tumor volume). The dose is given to PTV2 and PTV1 is same as the dose of 3D-CRT technique. For PTV1, the dose of 50Gy divided to 25 fractions that is equivalent to the dose of 54Gy divided to 30 fractions. These two methods were used in clinical treatment. The boost is only applicable to PTV3 or crude tumors. Because the number of fractions of SIB-IMRT plans is 30, the treatment can be completed within 6 weeks or 40 days.

II. METHOD AND MATERIALS

1. Patients selection:

20 patients (12 with larynx and 8 hypopharynx cancers) of the Oncology Hospital were treated between April 2015 and December 2017 including 14 males and 6 females with mean age of 46.

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2. Planning techniques

Patients were treated with 70Gy to target volume, 60Gy to high risk nodes and 50Gy to low risk nodes. The treatment plans were performed by 2 methods:

- Simultaneous integrated boost radiation therapy with 3 different doses 2.2Gy/fraction for target volume, 2Gy/fraction for high risk nodes and 1.8Gy/fraction for low risk nodes. The total fraction is 30.

- Radiation therapy with 2Gy standard doses, including 3 stages as follows:

- Stage I: irradiate 50Gy to target volume, high risk and low risk nodes.
- Stage II: irradiate 10Gy boost to target volume.
- Stage III: irradiate 10Gy boost to target volume.

III.RESULTS

The SIB-IMRT plans were created and calculated by Eclipse13 [2], [3], [4]for structures of PTV 50, PTV 60 and PTV 70.

Figures 1, 2, 3 and 4 show overlapping by objectives

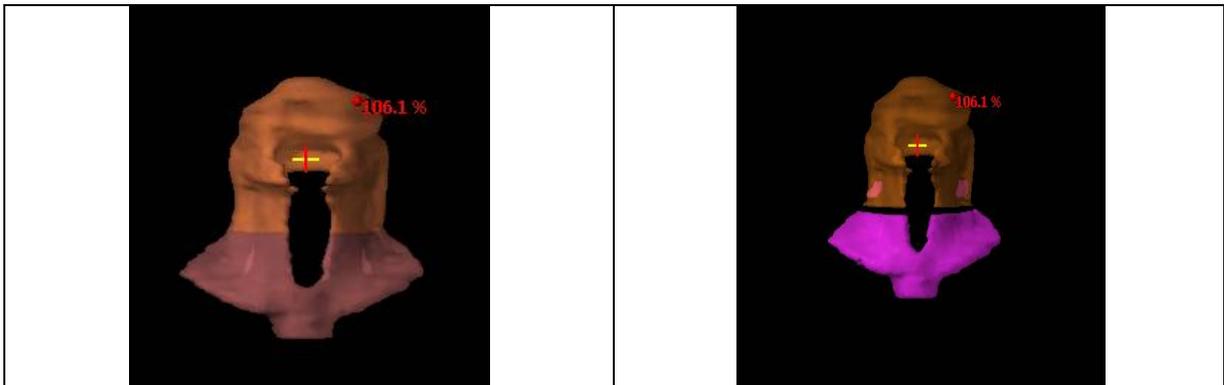


Fig1: Structures of PTV 50 and PTV 60

Fig.2: Structure of PTV 50 is outside of PTV 60

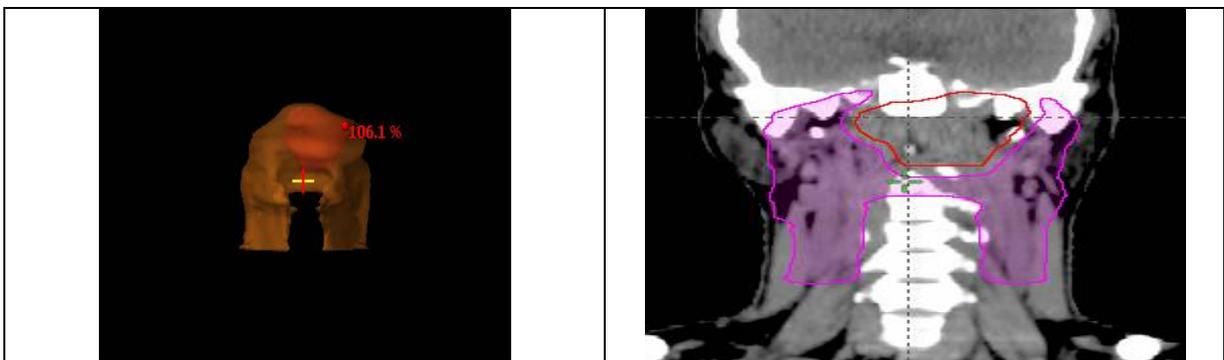


Fig3: structures of PTV 60 and PTV 70

Fig 4: Structure of PTV 60 is outside of PTV 70

We have set up the structures and the overlap between PTV and health organ as fig.5 and fig.6 below:

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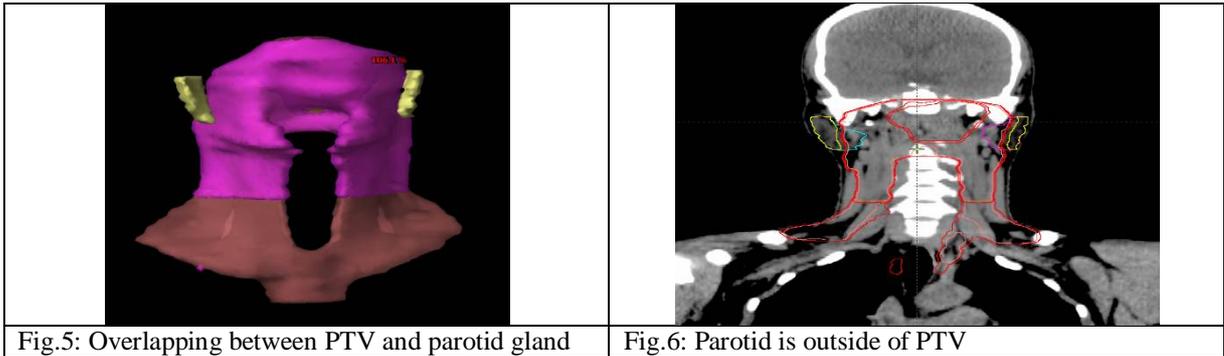


Fig.5: Overlapping between PTV and parotid gland

Fig.6: Parotid is outside of PTV

Setting irradiation field: SIB with IMRT plans were designed with nine coplanar IMRT beams and they weren't symmetrical parallelism. The beam geometry used nine none-coplanar radiation beams, gantry angles: 320°, 280°, 240°, 0°, 40°, 120° and 160°, see fig.7:

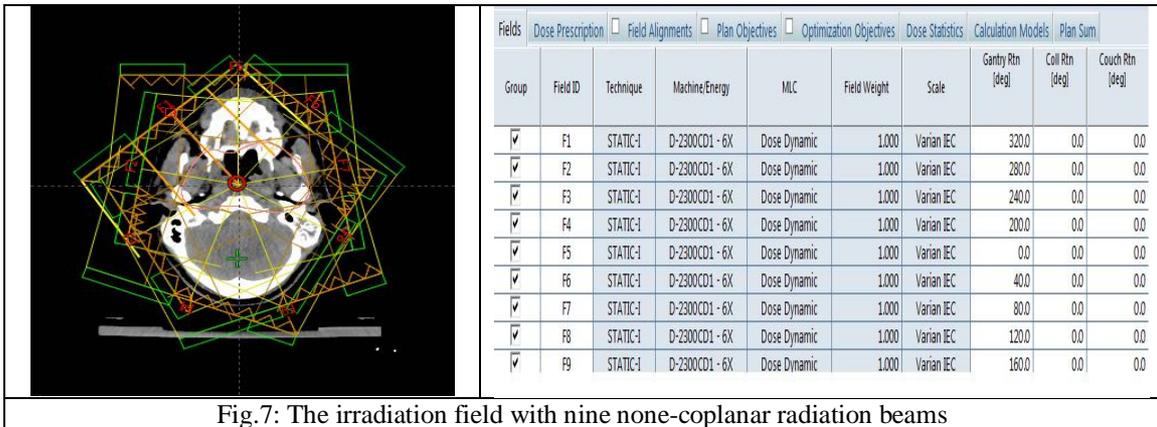


Fig.7: The irradiation field with nine none-coplanar radiation beams

We have set the dose limit outside PTV and created values to smooth for MLC (fig.8) and we have also set a dose limit on OAR. (fig.9)

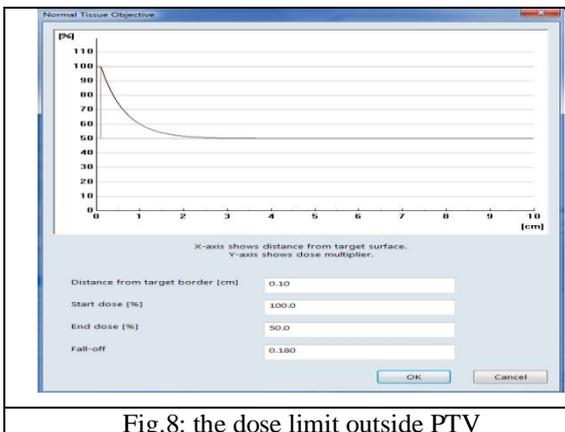


Fig.8: the dose limit outside PTV

ID	MLC	Method	X Smooth	Y Smooth	Minimize Dose	Fixed Jaws	Field Weight
F1	MLC 80	Beamlet	40	30	0	<input type="checkbox"/>	1.000
F2	MLC 80	Beamlet	40	30	0	<input type="checkbox"/>	1.000
F3	MLC 80	Beamlet	40	30	0	<input type="checkbox"/>	1.000
F4	MLC 80	Beamlet	40	30	0	<input type="checkbox"/>	1.000
F5	MLC 80	Beamlet	40	30	0	<input type="checkbox"/>	1.000
F6	MLC 80	Beamlet	40	30	0	<input type="checkbox"/>	1.000
F7	MLC 80	Beamlet	40	30	0	<input type="checkbox"/>	1.000
F8	MLC 80	Beamlet	40	30	0	<input type="checkbox"/>	1.000
F9	MLC 80	Beamlet	40	30	0	<input type="checkbox"/>	1.000

Fig.9: The created values to smooth for MLC

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Table 2 is the dose distribution to PTV for patient with the name is Dang Ngoc Huynh who has cancer of nasopharyngeal (T2N0M0)

PTV	Volume	Standard dose	SIB
		2Gy	1.8, 2.0, 2.2Gy/fraction
PTV50	99%	48	52
	95%	50	54
PTV60	99%	57.5	57.8
	95%	59.5	59.4
PTV70	99%	66.3	64.5
	95%	70	66
	20%	≤77	72

Table 2: The dose distribution to PTV of patient Dang Ngoc Huynh

Table 3 is the dose distribution to OARs for patient Dang Ngoc Huynh:

OAR	Volume	Dosage limit	Standard dose	SIB:
			2Gy	1.8, 2.0, 2.2Gy/fraction
Brainstem		max ≤54Gy	48.2	47.89
Brainstem+1mm	1%	max ≤60Gy	48	47.45
Spinal cord		max ≤45Gy	33	35.08
Spinal cord+1mm	1cc	max ≤50Gy	32.2	35.41
Optic chiasma		max ≤54Gy	13	14.69
Optic nerve		max ≤54Gy	9	8.59
Parotid gland		mean ≤26Gy	24.5	23.6
Eye		mean ≤35Gy	6.5	4.71
Lens		max ≤10Gy	6.4	6
Inner ear		mean ≤50Gy	40.5	40.81

All these treatment plans were performed on the subsequently (SIB) and conventional (conv.) IMRT plans were compared using dosimetric parameters from dose volume histograms. (fig.10)

Target and OAR dose results are shown on dose volume histogram DVH after simultaneous integrated IMRT plan for patient Dang Ngoc Huynh.



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- [6] James Welsh, Matthew B. Palmer, Jaffer A. Ajani, Zhongxing Liao, Steven G. Swisher, Wayne L. Hofstetter, Pamela K. Allen, Steven H. Settle, Daniel Gomez, Anna Likhacheva, James D. Cox, Ritsuko Komaki, "Esophageal Cancer Dose Escalation Using a Simultaneous Integrated Boost Technique", International Journal of radiation oncology, vol 82, issue 11, pages 468, 474
- [7] G. Studer, PU Huguenin, JB Davis, G. Kunz, UM Lutolf, C. Glanzmann, "IMRT using simultaneously integrated boost (SIB) in head and neck cancer patients" BioMed Central, Radiation Oncology, Published online 2016
- [8] Evangelia Peponi, Christoph Glanzmann, Guntram Kunz, Christoph Renner, Katja Tomuschat, Gabriela Studer, "Simultaneous Integrated Boost Intensity-Modulated Radiotherapy (SIB-IMRT) in Nasopharyngeal Cancer", Springer link, vol.186, issue 3, papers 135-14
- [9] A. Fogliata, A. Bolsi, I. Cozzi, J. Bernier, "Comparative dosimetric evaluation of the simultaneous integrated boost with photon intensity modulation in head and neck cancer patients", Radiother Oncol, 69, 267, 2003