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Department of Radiology University of Yamanashi

Comparison of five types of adaptive X-ray treatment planning technique for locally advanced non-small cell lung cancer

M. Saito[1], T. Komiyama[1], K. Marino[1], S. Aoki[1], Y. Maehata[1], M. Matsuda[1], T. Akita[1], H. Suzuki[1], K. Ueda[1], and H. Onishi[1]

1) University of Yamanashi, Chuo, Japan

INTRODUCTION & PURPOSE

In recent years, radiotherapy has received more attention for the treatment of locally advanced non-small cell lung cancer (LANSCLC), because Durvalumab after chemoradiotherapy in Stage III NSCLC showed better prognosis than placebo in the PACIFIC clinical trial (1). For the treatment planning, some reports showed dosimetric benefit for target dose coverage and lung dose reduction by using intensity modulated radiotherapy (IMRT) and IMRT/VMAT hybrid beam (2)(3). Although these studies used only the initial CT on first fraction, multiple CT images adapted to changes in tumor/patient shape is usually used in clinical situation. In addition, recently, not only IMRT/VMAT, but also 3DCRT optimization has been available in a commercial treatment planning system (TPS). Therefore, we focused on the 3DCRT optimization and adaptive planning.

This is the first study to evaluate the following five types of adaptive treatment planning techniques for LANSCLC; (a) forward planned 3DCRT (f-3DCRT), (b) inverse planned 3DCRT (i-3DCRT), (c)volumetric modulated arc therapy (VMAT), (d) initial 3DCRT and boost VMAT (3DCRT+VMAT), and (e) hybrid beam of fixed IMRT and VMAT (Hybrid). The purpose of this study was to compare five types of adaptive X-ray treatment planning technique for locally advanced non-small cell lung cancer (LANSCLC) patient.

METHOD

- This retrospective study was approved by institutional reviewers bord(IRB) in university of Yamanashi (receipt number: 2271).
- Following five types of treatment plan (60Gy/30Fr) were created for 13 stage Ⅲ NSCLC patient (Male: 9, Female:4)
- All plans were created for two CT images (initial CT image on first fraction and boost CT image on intermediate fraction), and then we evaluated the accumulated dose between them created by using deformable image registration
  a. Forward planned 3DCRT (f-3DCRT) was created with 2-6 fixed beams.
  b. Inversed planned 3DCRT (i-3DCRT) was created by 8 fixed beams with optimizing gantry angle, collimator angle, beam shape, and beam weight.
  c. VMAT was created by 1-3 partial arcs.
  d. Combination of f-3DCRT and VMAT was created.
  e. IMRT/VMAT hybrid was created by 2 fixed IMRT beams and 1-2 partial arcs.

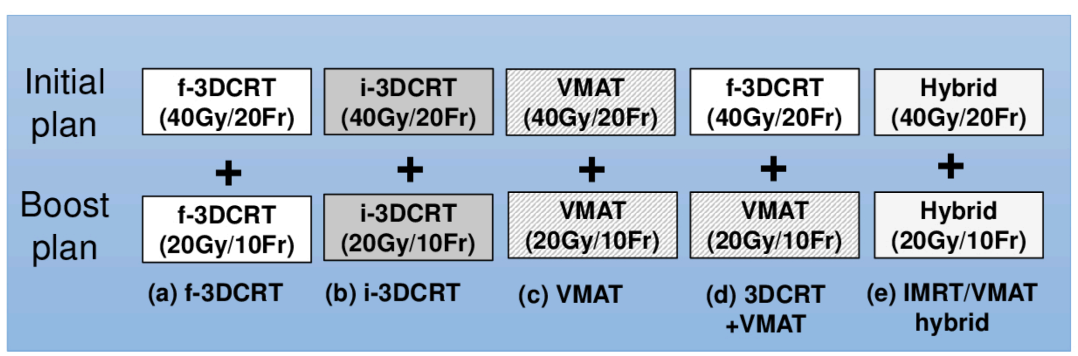

Fig.1 Five types of treatment plan on two CT images

RESULTS

Figure 2 shows the typical dose distribution (Patient 6). For the target coverage, the VMAT and the hybrid showed better conformity index than other techniques. Comparing the f-3DCRT and the i-3DCRT, the latter showed better conformity index. For lung dose, the VMAT and the hybrid showed the improvement of lung volume receiving >20 Gy (V20Gy), while lung volume receiving >5 Gy (V5Gy) of the 3DCRT methods was lower than that of VMAT and hybrid.

Important dose index and dosimetric features are summarized in Table 1. There was significant improvement about CI and V20 for VMAT and Hybrid compared with other techniques ($p<0.05$). On the other hands, 3DCRT techniques provided lower V5 and monitor unit (MU) than VMAT (average MU of initial plan: 255±13.2 (f-3DCRT) vs. 281±10.5 (i-3DCRT) vs. 655±159 (VMAT), $p<0.05$).

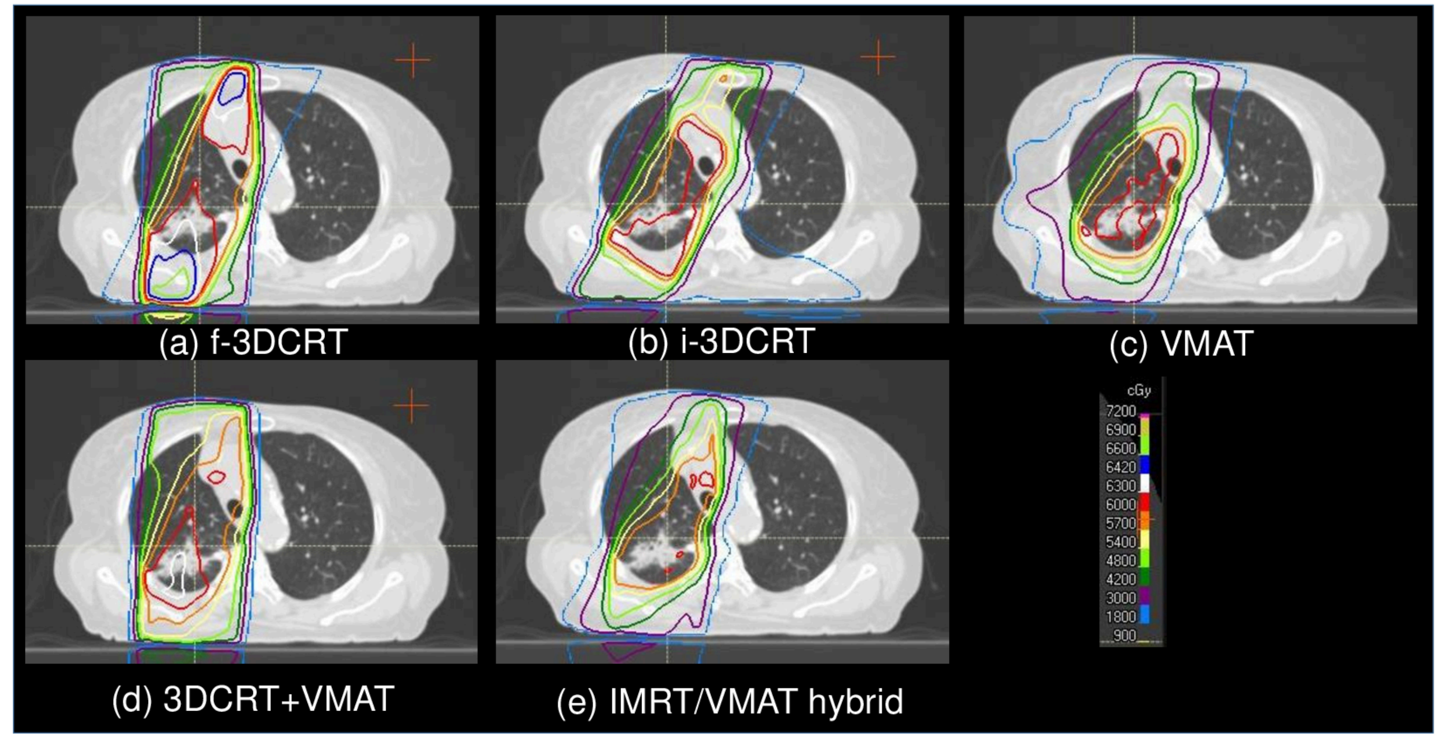

Fig.2: Typical dose distribution for five types of treatment technique (Patient 6).

Fig.2: Dose index and monitor unit for each technique (n=13, mean±s.d.)

		f-3DCRT	i-3DCRT	VMAT	3DCRT +VMAT	IMRT/VMAT Hybrid
PTV	D98%	51.3±2.24	51.2±3.87	53.2±3.65	53.5±1.94	53.3±2.99
	D50%	59.9±0.27	59.9±0.52	60.0±0.07	60.0±0.21	59.8±0.28
	D2%	63.9±2.53	62.6±1.51	61.4±0.31	62.9±1.47	61.2±0.63
	Dmean	59.5±0.51	59.2±0.74	59.5±0.28	59.7±0.42	59.5±0.73
	Conformity index	0.34±0.10	0.57±0.10	0.86±0.08	0.61±0.12	0.83±0.11
Lung	V20Gy	21.0±10.6	20.9±6.45	19.5±7.4	20.0±10.0	17.7±7.86
	V5Gy	34.9±14.5	39.8±10.6	48.0±17.4	36.9±14.9	43.1±15.4
	Dmean	11.3±4.82	11.4±3.36	11.2±3.90	11.0±4.77	9.56±4.71
Spinal cord	Dmax	42.9±5.48	32.7±6.73	32.6±6.68	44.3±8.17	34.5±9.21
Esophagus	Dmean	26.4±12.9	29.2±10.9	26.9±11.5	26.5±12.3	24.6±11.0
Heart	Dmean	7.68±8.20	8.53±8.93	6.67±6.70	6.82±7.46	6.62±6.94
Monitor Unit	Initial plan (40Gy/20Fr)	255±13.2	281±10.5	450±110	255±13.2	665±159
	Boost plan (20Gy/10Fr)	273±24.3	279±14.7	411±101	411±101	612±113

CONCLUSIONS

We compared five types of adaptive X-ray treatment planning technique for LANSCLC. In conclusion, the hybrid might be best choice for improvement of dose distribution. On the other hands, some 3DCRT combined methods could provide some benefit for lowest monitor unit and lung V5Gy.

REFERENCES

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CONTACT INFORMATION

Corresponding author: *Masahide Saito, Ph.D.*

Department of Radiology, University of Yamanashi

E-mail: ***masahides@yamanashi.ac.jp***