A Novel Method to Evaluate Local Recurrence of Lung SBRT using Follow-up PET

Although the method utilizing the maximum standard uptake value (SUV_{max}) 18F-FDG Positron Emission Tomography (PET) to assess the outcome of lung stereotactic body radiotherapy (SBRT) has been widely accepted in practice, its reliability has frequently been challenged[i]. The purpose of this study is to explore and test a novel method using a self background-corrected SUV_{max} ($cSUV_{max}$) in detecting local recurrence after lung SBRT.

Method and Materials: 20 qualified patients treated out of 38 patients treated with SBRT for a single lung malignant lesion between May 2009 and December 2009 were enrolled in the cohort study. All had pre- and at least one post-treatment PET images available at the time of study. The mean normal tissue SUV from the descending aorta was sampled as baseline to divide SUV_{max} of tumor site. The resultant $cSUV_{max}$ was used for assess the local control or possible recurrence. The result was then compared with that using SUV_{max} alone method.

Results: The average follow-up length was 48.9 weeks ranging from 18.6 to 115.0 weeks. The mean SUV of descending aorta was measured as 1.821±0.364, ranging from 1.173 to 2.576. When using SUV_{max} with 2.50 threshold and $cSUV_{max}$ with 1.52 threshold, only 70% or less positive rate for pre-SBRT PET (table 1) and 33% and less negative rate for PET taken < 29 weeks post-SBRT (table 2) were displayed. The analysis for PET with ≥ 29 weeks follow-up of the locally controlled cases are tabulated in table 3, in which $cSUV_{max}$ indicated all under its threshold, while 2 cases (5%) displayed positively when using SUV_{max}. In one clinically confirmed marginal recurrent case, both methods showed significantly high and progressively elevated values in the two follow-up PET. For one clinically suspected recurrent case, only $cSUV_{max}$ displayed progress from marginal (1.58) to moderate (1.73) higher values in two follow-up PET(fig. 2), while showed negatively (<2.5) with SUV_{max} (fig.1).

Table 1. Pre-SBRT Analysis for Maximum-SUV of PTV

	Maximum SUV	Corrected MaxSUV
Mean Value	6.28	3.76
SD	0.92	0.81
<Threshold Cases	6	7
>Threshold Cases	14	13
<Threshold	30%	35%
>Threshold	70%	65%

Note: The corresponding thresholds are 2.50 and 1.52.

Table 2. Analysis of PET at Followup of < 29 Weeks

	Maximum SUV	Corrected MaxSUV
Mean	4.14	2.10
SD	2.84	1.29
<Threshold	25%	33%
>Threshold	75%	67%

Note: Total 12 PET studies. Results are inconclusive.

Table 3. Analysis of PET at Followup of ≥ 29 Weeks

	Maximum SUV	Corrected MaxSUV
Mean	2.03	1.17
SD	0.53	0.27
<Threshold Cases	19	21
>Threshold Cases	2 *	0
<Threshold	95%	100%
>Threshold	5%	0%

*Note: * false possitive*

Figure 1. Maximum SUV of Tumor in Follow-up PET

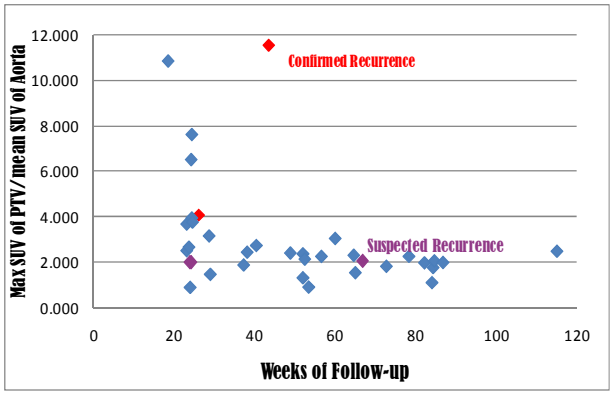
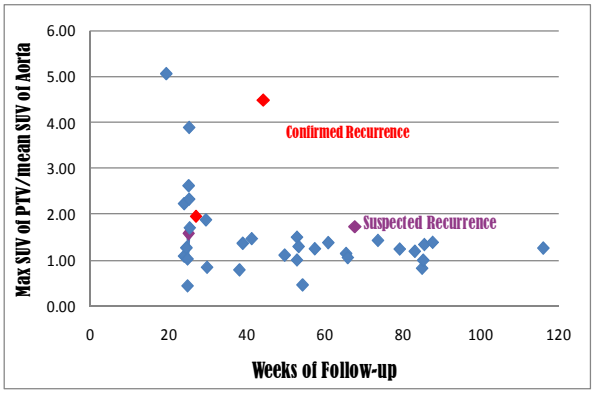


Fig 2. Self-Corrected SUV_{max} in Follow-up PET



Discussion: The SUV_{max} has been well accepted as objective parameter to evaluate the biological activity for glucose uptakes of the tumor site. However, it still subject to multiple biological factors, such as blood glucose level, exiting pneumonitis, tumor uptake time, motion; and technical factors, uptake time. SUV_{max} will also be significantly affected by scanning technique parameters and the scanner used[ii]. Regardless its uncertainty, many still depend on the 2.5 threshold of SUV_{max}[iii] to identify local recurrence of lung SBRT[iv]. For the follow-up PET of 29 weeks or less post-SBRT, SUV in the tumor site displayed may be elevated by post radiation changes resulting in higher false positives in this study. However, for the later follow-up PET, we have found 5% of false positive when using SUV_{max}, which is less reliable than that using $cSUV_{max}$ for locally controlled cases. Since the baseline - mean SUV of descending aorta show a large variation from 1.173 to 2.576 as seen in this investigation, an absolute value such as SUV_{max} is subject to great errors. The suspected recurrent case in this study may be categorized as progressive metabolic disease which was reported to be observed in 18% of lung SBRT patients with 2 year follow-ups[v].

Conclusion: The SUV_{max} in lung tumor site corrected by the mean SUV of descending aorta or $cSUV_{max}$ provided a more reliable parameter than using SUV_{max} alone in predicting the local control and recurrence for follow-up PET of patients after lung SBRT. The method used in this study objectively displayed a strong correlation between low $cSUV_{max}$ and local control following lung SBRT in this investigation, otherwise a local recurrence is suggested.

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[iv] Chang AJ. et al.: The role of PET for NSCLC; PRO 2011; 1:282-288

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