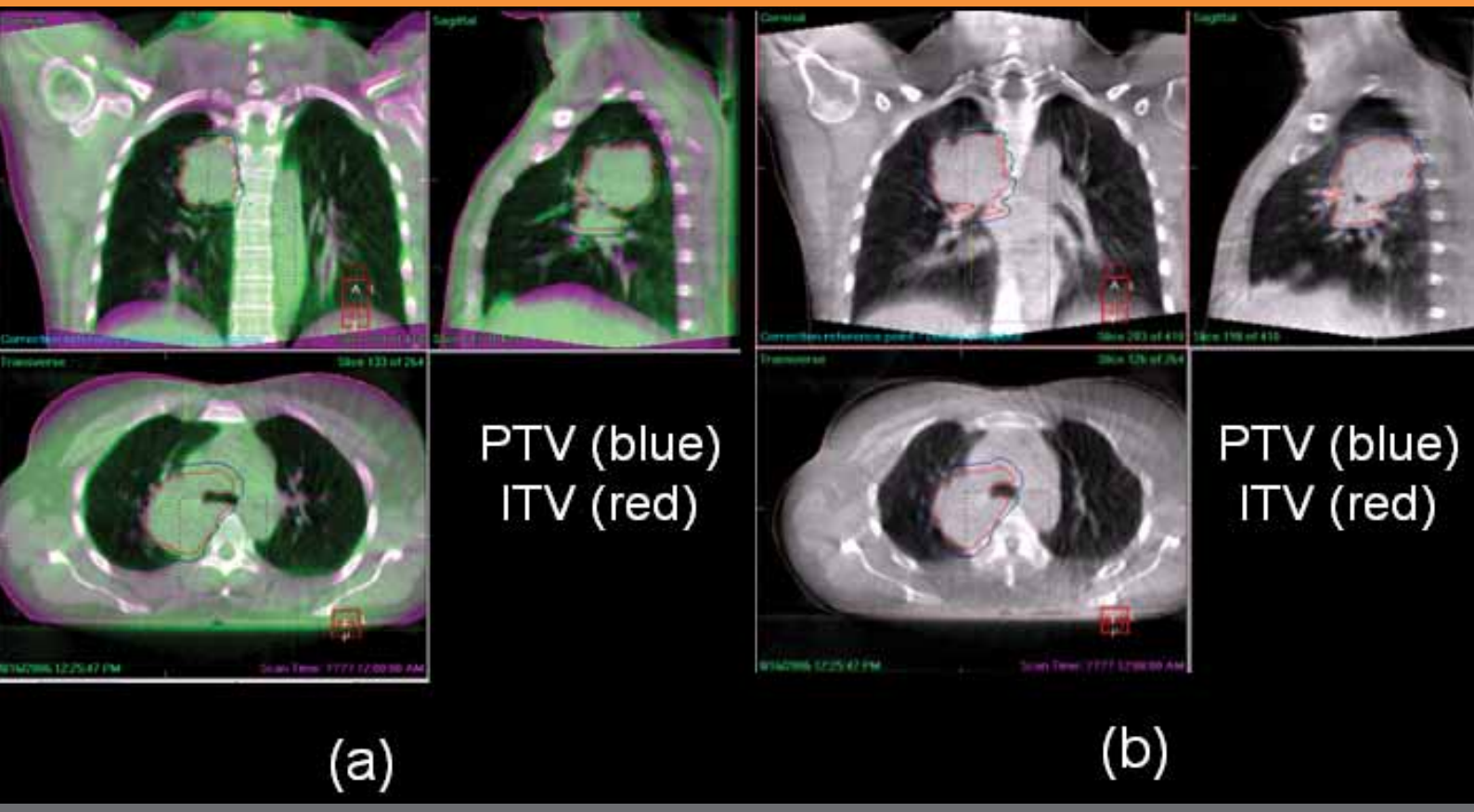
Accuracy study

Evaluation of tumor response and an adaptive treatment strategy in lung RT using 3D VolumeView™ imaging



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PURPOSE: X-ray volume imaging (XVI) serves primarily as a tool to improve the accuracy of patient positioning in radiation therapy. In addition, VolumeView images can be used to observe tumor response for non-small-cell lung cancer patients over the course of external beam radiation therapy. In this study, we have evaluated the tumor regression for NSCLC during radiotherapy. We have also investigated an adaptive treatment strategy designed to increase the dose delivered to the residual sub-volume of the tumor. The strategy also seeks to maintain the normal tissue sparing and deliver the prescribed dose to the original tumor volume in order to avoid increasing the risk of marginal recurrence.

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Evaluation of tumor response and an adaptive treatment strategy in lung RT using 3D VolumeView™ imaging

Authors

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Methods and materials

15 NSCLC patients treated between April 2006 and December 2007 with a conventional fractionation scheme were analyzed in this study. The patients were treated with a motion-encompassing treatment plan and daily VolumeView™ alignments were performed. 4D-CT imaging was used for treatment planning. Patients were positioned in the supine position utilizing a wing-board and were scanned during normal free-breathing.

The internal target volume (ITV) was determined using the maximum-intensity-projection (MiP) CT data to account for organ motion. A 5mm PTV margin was used to account for set-up error. The range of the prescribed dose was 60 to 70Gy over a course of 30 to 36 fractions, with either 1.8Gy or 2.0Gy per fraction. On-line set-up correction was based on the daily VolumeView imaging prior to treatment. To evaluate tumor regression during the course of treatment, the ITV was contoured on the first and subsequent weekly VolumeView images. For patients with a decrease in ITV of more than 50%, their treatment was re-planned retrospectively, aiming to boost the residual sub-volume of the ITV while maintaining the prescription dose to the original ITV and normal tissue sparing.

Results

Three out of the 15 patients had more than 25% tumor shrinkage over the course of treatment. One patient had tumor shrinkage of 71% halfway through the course of treatment. For this patient, a dose of 64.8Gy (1.8Gy x 36 fractions) was prescribed. Figure 1 shows the VolumeView™ image taken on the 1st fraction. The VolumeView image was registered with the reference CT for set-up correction. See figure 1.

Figure 2 shows the tumor shrinkage as observed from the daily VolumeView image in the 18th fraction.

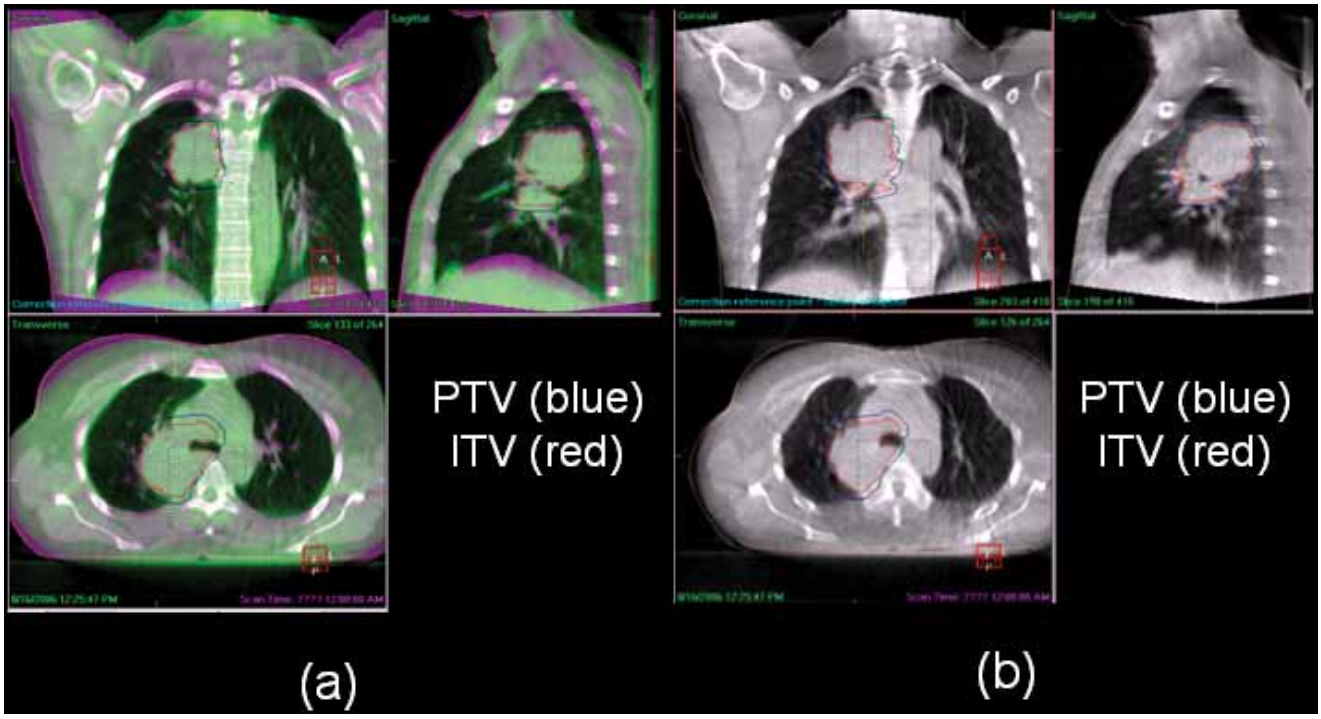

Figure 1: images showing the PTV and ITV in the 1st fraction: (a) VolumeView registered (shown in green) with the reference CT (shown in purple) for on-line treatment correction, (b) only the VolumeView image is shown after registration with the reference CT.

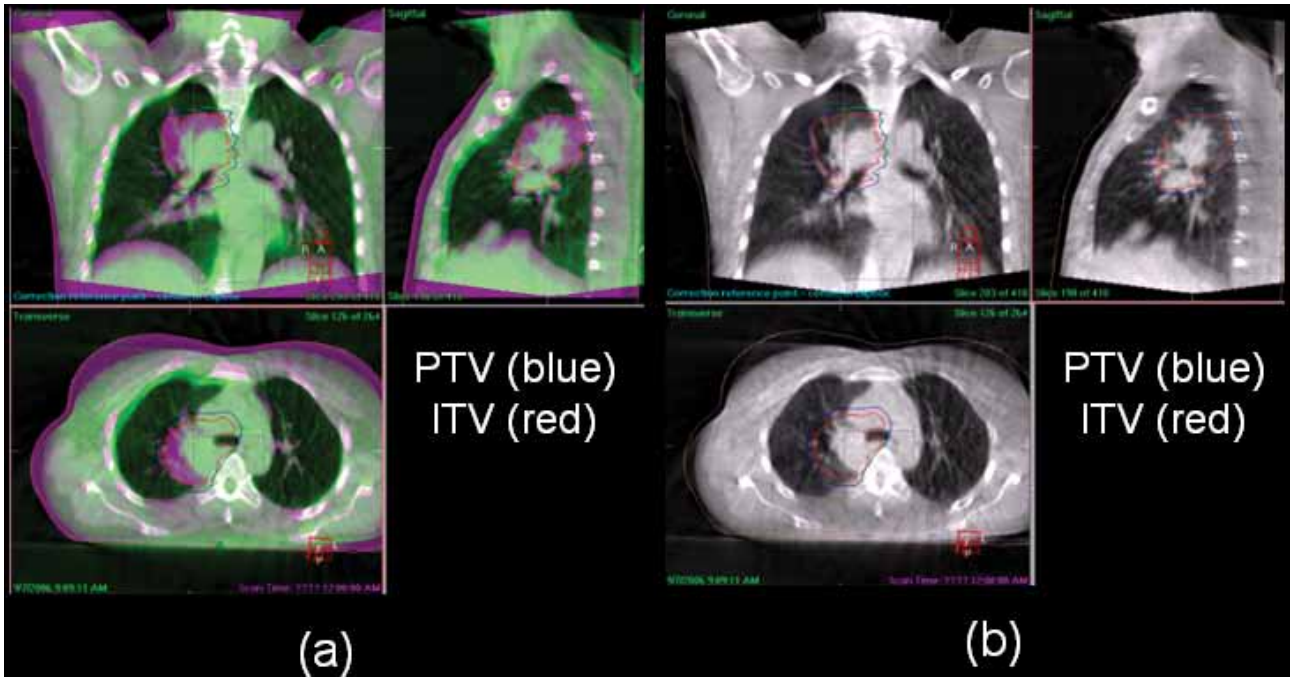

Figure 2: tumor shrinkage shown in the 18th fraction: (a) VolumeView registered (shown in green) with the reference CT (shown in purple) for on-line treatment correction. (b) only the VolumeView is shown after registration with the reference CT.

A new treatment plan was created retrospectively, aiming to boost the residual sub-volume of the ITV for the remaining fractions. The seven-field IMRT plan with 95% of the ITV covered by 65Gy was modified to include a boost to the residual sub-volume of the ITV to 70.1Gy, with minimal changes in prescription dose to the original ITV (from 65.0Gy to 65.7Gy) and normal dose sparing. For example, the change in the V20 and the mean lung dose for the ipslateral lung were 0.9% (from 6.0% to 6.9%) and 2.0Gy (from 5.2Gy to 7.2Gy) respectively. The maximum dose to the spinal cord remained unchanged at 42.0Gy.

(continued overleaf)

Conclusions

In addition to IGRT, VolumeView imaging can also be used to document and evaluate tumor regression during a course of radiation therapy of non-small-cell lung cancer. An adaptive treatment strategy can be used to boost the residual sub-volume of the ITV while maintaining tissue sparing and avoiding the risk of increased marginal recurrence.

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