

The potential reduction in the PTV margin, accomplished by minimizing the effects of respiratory organ motion, may be as great as the reduction in the treated volume margin gained by using conformal therapy techniques. A system has been implemented that acquires diagnostic images and delivers radiotherapy gated to a patient's respiratory cycle. A respiratory monitor is used to characterize a patient's respiratory mechanics, using a sensor placed in the patient's mouth and employing a capnograph (CO<sub>2</sub>) and a differential pressure pneumotachometer (flow, pressure, volume). Readings are obtained 100 times per second and transmitted to a computer, analyzed in real time using one of several algorithms, and gating signals are sent at the appropriate time. X-ray images are obtained when the CO<sub>2</sub> level turns sharply negative at the start of inhalation and when the CO<sub>2</sub> level turns sharply positive at the start of exhalation. These respectively document the reference organ positions for gated radiotherapy and the range of organ motion that occurs in ungated treatments. Parallel analysis of flow, pressure and volume minimizes false positives. Continuous image acquisition and gated radiotherapy treatments are accomplished using a continuous exposure algorithm centered about the point of full exhalation, the most reproducible point in the respiratory cycle. We have radiographically documented elimination of 80-90% of the diaphragmatic movement. Gated treatments on our Primus linear accelerator are accomplished by keeping the accelerator in a continual powered up condition and turning the beam off by injecting electrons out of phase using a specially modified trigger circuit.

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