Incorporating organ motion due to breathing into 3D dose calculations: Sensitivity to variations in motion

We have previously described a method to incorporate the effects of organ motion due to breathing into 3D dose calculations for treatment of liver disease. This method uses an analytic function to describe inferior-superior liver motion during free breathing. Although periodic, each cycle is generally asymmetric, with the majority of time spent near the exhale position. Our analytic function includes parameters that describe the amplitude (exhale to inhale) of the motion and the degree of asymmetry (time at exhale relative to inhale). Representative parameter values are selected by observation for each patient. However, these parameters may vary from the representative values over the course of treatment (e.g. patient may take a few deep breaths over the course of treatment). This study demonstrates the effects such variations may have on the predicted outcome in dose. Monte Carlo-based direct simulations were used to compute 3D dose distributions that included the effects of liver motion due to breathing. The amplitude and/or shape of the breathing cycle function was changed from the representative values for various fractions of the total treatment. The significance of differences in the liver dose distribution was judged by changes (if any) in our normal tissue-based protocol for prescribing dose. Quantification of these effects will be useful in directing future efforts in describing and controlling organ motion due to breathing.

Work supported by NIH *grant no.* P01-CA59827 *and the Sidney Kimmel Foundation*