Purpose:

1. To justify the respiratory induced lung tumor motion is correlated to volume change in lung
2. To show that such motion is a hysteresis type of motion, i.e. the inspiration and expiration paths the tumor follows are different.

Methods:

The model equation was generated based on the data obtained from the axial displacement versus volume plot of the lung by Verschakelen et al (1989). The time variation of the lung volume change was introduced using linear and non-linear functions. After comparison with literature (Lu et al, 2006), we verified the non-linear time variation is more reliable. The lung motion amplitude as a function of time was then plotted and fitted with sinusoidal function. The dynamic 3D lung motion was simulated as a function of time based on the model equation. Two independent simulations were performed and compared:

1. Independent tumor motion amplitude and lung volume change.
2. Lung tumor motion dependent on the lung volume change.

Results:

1. The model function generated from the fitting curve is periodic function with even power. This agrees with the periodic nature of respiration induced lung motion and also with the fact that longer time is spent at the end of exhalation than at the end of inhalation, which is proven by other researchers too.
2. Based on the simulated dynamic lung motion, we observe that the lung tumor motion is well correlated to the lung volume change.

Conclusions:

Clinically, chest wall as well as diaphragm amplitude measurements are used to provide lung motion gating window. In this study, we observe that respiration induced motion of the lung tumor is correlated to the lung volume change, and this can give a good prediction of:

1. The 3D location of the lung tumor.
2. Density change of the lung.