Purpose: To study the feasibility of using hysteresis motion characterized by a free-breathing lung motion model as a marker for tumor margin in lung patients.

Methods: Anatomical and physiological evidences have shown that solid tumors typically have more collagen in tumor stroma and consequently are firmer than surrounding normal tissues. For patients with lung cancer, the increased firmness in tumor stroma would alter pattern of breathing motion, mostly prominent in the hysteresis component that is defined as the variation between motion trajectories during inhalation and exhalation. A free-breathing lung motion model, x= x0+alpha*v+beta*f, where v and f denote tidal volume and air flow respectively, decomposes breathing motion into a non-hysteresis component alpha*v, which is purely due to air filling, and a hysteresis component beta*f. Four patients acquired in Cinè mode were analyzed and beta was obtained by linear least-square fitting registered motions to air flows measured by spirometry.

Results: Hysteresis motions were found to gently change in magnitude and direction throughout whole lungs except around cancerous regions where the hysteresis motions turn sharply following the curvature of the tumors, indicating shear motions along the interface between tumors and surrounding normal tissues.

Conclusions:The vector map of hysteresis motion demonstrates affinity to tumor curvature in the vicinity of the tumor, reflecting intrinsic physiological and mechanical changes at the transition from tumor stroma to surrounding normal tissue. It has the potential to be used as a marker for tumor margin.