Purpose: Respiration-induced kinematics of thoracic tumors suggests a simple analogy with elasticity, where a strain is used to characterize the volume of interests. The application of the biomechanical framework allows for the objective determination of tumor characteristics.

Methods: The deformation of a given tissue element can be determined if its displacement is known. The latter can be obtained from 4DCT scans using image registration of the end of inhalation and exhalation CT volumes. The averaged right Cauchy-Green strain tensor was determined for each of the 15 retrospectively analyzed thoracic GTVs. The departure of the strain tensor from the identity matrix gauges the departure of the medium from rigidity. The averaging was carried out in Log-Euclidean framework. The fractional and geodesic anisotropy factors were determined for the tensor.

Results: The amplitude of GTV motion varied from 0.64 to 4.21 with the average of 1.2cm. The GTV size ranged from 5.16 to 149.99cc with the average of 43.19cc. The tumor deformation is inconsiderable and the tensorial anisotropy is small. The Log-Euclidean distance of averaged strain tensors from the identity matrix ranged from 0.06 to 0.31 with the average of 0.19. The Frobenius distance from the identity matrix is similar and ranged from 0.06 to 0.35 with the average of 0.21. Their fractional anisotropy ranged from 0.02 to 0.12 with the average of 0.07. Their geodesic anisotropy ranged from 0.03 to 0.16 with the average of 0.09. These values also indicate insignificant deformation.

Conclusion: The biomechanical framework allows for the quantitative description of the tissue or anatomical regions of interest. Such regional characterization of volume of interests can be used in the objective evaluation of changes of the anatomy during the treatment or after the treatment. It might be used for correlation of outcome studies with objective characterization of changes within biomechanical framework. These objective characteristics do not rely on human interpretation. The measured changes might have predictive characteristics for the therapeutic success of the treatment.