Bronchial asthma and chronic obstructive pulmonary disease (COPD) are one of the most common medical conditions in the world. It is estimated that in 2013 about 242 million people had asthma and ca. 489,000 died worldwide because of it. COPD affects nearly 5 percent of the global population. In both of these diseases, chronic inflammation of the respiratory tract is an important underlying factor, though the pathophysiology and clinical presentation varies greatly. The structural changes in the airways (remodeling) play an important role in the pathogenesis of both of these diseases as well. The pattern of remodeling is different in asthma and COPD. To assess remodeling of the airways the most commonly used technics are: analysis of histopathological biopsies, high-resolution computed tomography (HRCT) or endobronchial ultrasound (EBUS) measurements. New studies show that bronchial wall remodeling in obstructive lung disease influences the mechanics of airflow in the lungs. Theoretical models suggest that airway obstruction depends mainly on the mucosal-to-submucosal elasticity ratio and the mucosal and submucosal thickness.

The main objective of this study is to assess the elasticity of bronchial wall biopsies in obstructive lung diseases measured by atomic force microscope (AFM). This will be the first study of bronchial wall biopsies with AFM – this method has never before been used to evaluate bronchial wall elasticity in human. Our preliminary findings show significant differences in bronchial wall elasticity between patients with asthma, COPD and healthy control, but a bigger population must be studied for satisfactory statistical sampling.

We want to verify if elasticity of bronchial wall biopsies measured by AFM corresponds to the structural changes in the airways (remodeling) and is different in bronchial asthma and COPD. Furthermore, we suspect that elasticity of bronchial walls is dependent on the degree of its structural changes and directly influences the way air flows through the airways, resulting in changes measured in pulmonary function tests.

Our study will include 3 groups of adult subjects: 20 patients with asthma, 20 patients with COPD and 20 healthy subjects. All patients will be in stable clinical condition, without exacerbation in the past three months. Routine laboratory tests, pulmonary function tests, bronchofiberoscopy with endobronchial ultrasound (EBUS) and obtaining endobronchial biopsies will be carried. Bronchial wall thickness and its layers will be measured with EBUS. Histopathological and immunohistochemical methods will be used to evaluate cell types, protein composition and morphometry of bronchial wall biopsies. In addition, bronchial wall biopsies will be send to the Nuclear Physics Institute of Polish Sciences Academy in Kraków to perform measurements with AFM.

Study of the mechanical properties of bronchial wall (elasticity) and remodeling in course of obstructive lung disease is an innovative application of AFM in clinical studies. It will enable us to assess if remodeling in obstructive lung disease has impact on elastic properties of bronchial wall. In addition, assessment of interactions between the elasticity of bronchial wall (AFM), the structure of bronchial tissue (EBUS, histopathology), the dominant type of inflammatory cells infiltrate, the deposition of proteins (immunohistochemistry) and ventilatory disturbances of the airways (pulmonary function tests) may significantly contribute to our knowledge concerning pathophysiology and mechanics of airways obstruction in obstructive lung disease. Direct measurement of bronchial wall elasticity will show if the newly developed theories about mechanical reasons for airway obturation are true. Furthermore, it may show perspective of new applications for AFM in pulmonary medicine diagnostics and treatment. It is planned to publish the results of the work in two international journals with impact factor (IF) and present them at an international conference.