Central airway obstruction produces symptoms of dyspnea, stridor, and obstructive pneumonia and is frequently increases the morbidity and mortality rates. The incident of central airway obstruction may be due to a variety of benign processes, malignant stenosis and airway complications following lung transplantation. Insertion of airway stents to open airway's obstruction can improve pulmonary function and the quality of life of patients suffering from obstruction. There are four main types of stents currently in use to open the obstructed airways, Silicone stent, balloon dilated metal stent, self-expanding metal stent and covered self-expanding metal stent. Each type of stent has its drawbacks and advantages. The major drawback of airways stents is formation necrosis of mucosa and fistula formation due to radial forces. Several studies have been done in the past few years to investigate the influence of airway stent on the patient's airway and pulmonary function. However, none were made to examine the effect of the radial forces exerted by the different stent on the airway. The objective of the present project, therefore, was to compare between the mechanical function of the four main types of airway stents, Silicone stent, balloon dilated metal stent, self-expanding metal stent and covered self-expanding metal stent.

Stress-strain numerical simulations were done using SolidWorks Simulations software in order to study the mechanical performance of each stent under radial forces. The results of the numerical simulation were compared with mechanical measurements. The mechanical measurements were done using experiment system that consists of force gauge with rising tension and self-made adaptors that connect the stent to the force gauge. Validation between the experimental measurements and numerical simulation revealed satisfied correlation.

Numerical simulations were performed on 8 different stents geometries. The geometries of the stents were designed according to the dimensions and architecture of the same stents that were used in the experiments (these stents were kindly given by Professor Kramer) and stents that are also being used in clinics. The stents models were then inserted into trachea model, which was built from two layers, a layer of smooth muscle and a layer of cartilage rings. The simulations were performed by SolidWorks Simulation Ver. 2011 which is commercial software of FEM methods using the Shrink Fit feature. The simulations were done to investigate the influence of different stent diameters, stent
geometries and stent materials on the radial stresses. In addition, the influence of inserting the stent into model of healthy trachea versus models of trachea with 30% symmetric and non-symmetric stenosis was examined.

The results of the simulations clearly showed correlation between the diameter of the stent and the stresses. Higher stresses were found in stents with larger diameter. The different in the stresses between stents with different diameter were even higher when the stents were inserted into model of healthy trachea compare to trachea with stenosis. Stents composed of Cobalt alloy and Stainless steel 316L exerted the highest stress value while stents composed of silicon exerted the lowest value. Metal stent with zigzag geometry exerted the higher stresses compare to other metal stent geometries. Covering metal stents with less stiff material as silicon or polyethylene reduce significantly the value of stresses. Stenosis (symmetric or non-symmetric) increases significantly the level of stresses in all stents.

In conclusion, the low stresses found in the silicon stents may be due to weak contact between the stent and the trachea and can explain its migration. Thus, silicon stents are recommended for use in case of short time therapy. Metal stents covered with silicon or polyethylene reduce the stresses on the trachea while still retain strong contact with it. Therefore, they may reduce formation necrosis of mucosa and fistulas while still prevent stent migration.