CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Chronic Obstructive Pulmonary Disease (COPD) is a disease which narrows the airway to the lungs progressively. The narrowing is mainly caused by the inflammation and thickening of the bronchi wall. As a result, airflow to and from the lungs are impeded. Thus, the symptoms that follow are shortness of breath, chest tightness, wheezing, chronic cough and sputum production. Cigarette smoking, exposure to air pollution, chemical fumes and dust further aggravates this progressive disease. National Heart, Lung and Blood Institute has recorded over 12 million people who are diagnosed with COPD who have yet to obtain treatments due to the minimal level of awareness regarding the disease. COPD was ranked sixth leading cause of death in 1990 and has been projected to become fourth leading cause of death worldwide by 2030 (Xiole Chen et al., 2011). Symptoms often worsen over time and can limit a patient’s ability to do routine activities. Gradually, simple everyday task such as walking, talking, and chores becomes a challenge and are subsequently inhibited in patient’s suffering with severe COPD. In most cases, COPD is diagnosed in middle-aged or older adults. Researches have yet to discover cures to reverse the damage to the airways and lungs. However, treatments and lifestyle changes can help a patient feel better, stay more active, and slow the progress of the disease.
Researches have taken various approaches to evaluate and treat this disease. However, the number of patients suffering from COPD is still recorded to be high in average (NH Johari et al. 2010) primarily due to the failure to detect the symptoms of COPD at an early stage. Most times, these symptoms are misunderstood for other diseases. Therefore, this problem can be resolved by understanding the behaviour of airflow in the lungs during breathing. Equipped with better knowledge of the airflow mechanism in the lungs, medical officers could prevent the severity of this disease.

There are many scholars in the field did a researches on the behaviour of air and solid flow through the airway. But however there are not many researchers studied on the behaviour of air/solid flow on obstructed airway. Particle deposition is vital importance during these investigations. These airway regions are where the inhaled particles deposited with toxic chemicals and microorganism are liable to inflame or swell (Ulvestad et al., 2001). Meanwhile, it is also a parameter that could possibly be obtained by chemical or imaging method especially for the lower airway whose diameter could be too small to measure the flow pattern or velocity profile. From the medical treatment perspective, understanding of the relation between flow pattern and particle deposition would benefit the oral or nasal drug delivery device design which may facilitate high drug-aerosol deposition in desired pulmonary regions and reduce side effects. Early studies of airflow in the lung airways include the experimental work by (Proetz and Schroter and Sudlow 2004). A few velocity profiles and flow patterns were presented for a double bifurcation model. In other experimental studies the central airway up to the third generation of the bifurcation was used.

In this study, Computational Fluid Dynamics (CFD) was being used to simulate the airflow of model. CFD has certainly come of decades in field of applications and academic research. In early times, CFD was only limited to high technology engineering area such as aeronautics and astronautics, but now it is widely used in many field for solving complex problems which are derived from different discipline of fluid mechanics and heat transfer. Most of the researcher in this field is relying on this simulations tool to predict the airflow in the lungs as it is very difficult to obtain using experimental studies. The capability of this simulation tool is proven to give a good approximation results (NH Johari et al., 2010).
A simplified model based on fifth to eighth generation human airway according to Weibel's 23-generation pulmonary model with a 70° bifurcation angle. The constrictions were place at different generation in the 4 generation airway model. Many researchers used Weibel’s 23 generation model as their research model because the symmetrical geometry and not to lose generality (H.Y Luo et al., 2007), (Arpad Farkas et al., 2007) (Xiaole Chen et al., 2009). The obstructed model is being modified from the reference model.

1.2 PROBLEM STATEMENT

Most of the early studies discuss about the symmetrical and asymmetrical airways and particle deposition (Maria Chiara Piglione et al., 2011), (Y.Liu et al., 2003), (Z.Zhang et al., 2004) and (X.Y Luo et al., 2004). They studied on the effect of bifurcation towards the airflow and particle depositions. The studies only analyse a smooth airway and the obstructed airways were ignored. Only a few did a research on obstructed airways (X.L Yang et al., 2005), (H.Y Luo et al., 2007) and (Xiole Chen et al., 2011). According to the studies, obstructed airway could alter the human airflow behaviour.

1.3 OBJECTIVE

Objective of the research are:

i. To determine the behaviour of the flow parameters through human airway with the presence of Chronic Obstructive Pulmonary Disease.

ii. To investigate the effect of different breathing mode on obstructed airway models