

Title	数値流体力学による鼻腔内湿度調整機能に関する研究
Author(s)	工藤, 之義
Citation	
Issue Date	2008-03
Type	Thesis or Dissertation
Text version	author
URL	http://hdl.handle.net/10119/4329
Rights	
Description	Supervisor: 松澤照男, 情報科学研究科, 修士

Study on function of control humidity in nasal cavity based on CFD

Yukinori Kudo (0610034)

School of Information Science,
Japan Advanced Institute of Science and Technology

February 7, 2008

Keywords: Nasal cavity, Humidity distribution, Humidification function, 3-dimensional reconstructed shape, Thermo-fluid analysis.

1 Background and purpose of research

Nasal cavity is a space that leads to the pharynx from the external nares in the forward of human's head and is a passage of air in breath. Nasal cavity is complex shape and has the various important functions. The main function are temperature adjustment(warming and cooling) and control the humidity for inspired air, olfaction of inspired air and resonant function. In this paper, I focused attention on the function of control the humidity. Inspired air is conditioned moderate temperature and humidity to maintain function of air passage and lung by nasal cavity. Lungs transport oxygen from inspired air into the bloodstream and release carbon dioxide from the bloodstream for expired air. Air passage helps to exchange of respiratory gases in the lungs effectively. Those functions are biogenic. Therefore, I figure that function of temperature adjustment(warming and cooling) and control humidity in nasal cavity is very important. I pay attention to function of control humidity in nasal cavity that is not elucidated.

Before now, thermo-fluid analysis using three dimension nasal cavity shape structured by computed tomography image are done, but these exclude humidity. While temperature bound up with Humidity, effect of

humidity in nasal cavity is not resolved. Purpose of research is by doing thermo-fluid analysis regarded humidity, I solve function of control humidity in nasal cavity and show how humidity exerts an influence on temperature.

2 Method

In this research, thermo-fluid analysis using three dimension nasal cavity shape structured by computed tomography image. Especially I pay attention to function of control humidity in nasal cavity and I do thermo-fluid analysis regarded humidity. Control humidity in nasal cavity is done by the wall in nasal cavity is covered with mucous membrane gives water vapor air which flows in nasal cavity. Because water vapor include air in nasal cavity, I think that Temperature in the nasal cavity is influenced by water vapor.

Basis equation are equation of continuity, Navier-Stokes equation, energy equation and advection-diffusion equation of water vapor. I solve these equations all together. I think that it is important to devise model of the nasal cavity wall to do thermo-fluid analysis regarded humidity, and I make two hypotheses about model of the nasal cavity wall. Our hypotheses are condition of temperature $34[^\circ\text{C}]$, relative humidity $100[\%]$ and condition of water layer. I apply those conditions and compared it. I compare calculation result applied condition of temperature $34[^\circ\text{C}]$, relative humidity $100[\%]$ with calculation result applied condition of water layer.

3 Result

First of all, thermo-fluid analysis of steady flow regarded humidity using three dimension nasal cavity shape structured by computed tomography image. Inflow temperature are $25[^\circ\text{C}]$ and $50[^\circ\text{C}]$ to confirm warming and cooling in the nasal cavity, Inflow relative humidity are $10[\%]$ (low humidity), $50[\%]$ (medium humidity) and $90[\%]$ (high humidity) to confirm control the humidity when whatever humidity inflow. In the result, thermo-fluid analysis applied condition of nasal cavity wall as water layer demonstrates value near really measuring temperature and relative humidity in nasal cav-

ity. And I confirm that relative humidity distribution in the nasal cavity depends on inflow relative humidity.

Next, only the suction of breath was assumed at the rest, thermo-fluid analysis of unsteady flow regarded humidity is done, and I show flow, temperature distribution and relative humidity distribution in the nasal cavity at each passage of time. And I study about function of control humidity in nasal cavity according to the passage of time were examined.