Simulation of Nasal Cavity Flow using Heat and Vapour Transport Wall Boundary Model

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Abstract

Among the several functions of the nasal cavity, temperature and humidity adjustments are important for preserving the trachea and lungs. The functions of the nasal cavity have been clarified in experiments investigating the condition in the nasal cavity. However, the difficulties of noninvasive mesurements have rendered nasal cavity simulations an attractive alternative. Data are readily obtained form a simulated result.

In this study, airflow, temperature, and humidity transfer in the human nasal cavity were investigated in nasal cavity wall model of temperature and humidity transport. The nasal cavity wall model was examined by simple geometory such as straigh pipe. The simulated result was verified by comparison with experimental data. A resonable agreement was attained between experimental data and a model incorporation the latent heat effect. The model simulates head and water exchange in the nasal cavity.

The four inhalation cases (hot-dry, hot-humid, cold-dry, and cold-humid) was simulated. In all cases, temperature and humidity of inhale air were adjusted to suitable physiological values. Temperature and humidity gradients were highest at the front of the nasal cavity. The influence of latent heat was clarified by comparing simulation results with and without latent heat under several inhaled air conditions. In the hot-humid inhaled air case, temperature in the Kiesselbach area was increased by latent heat of condensation, and relative humidity declined. In the other inhaled air cases, the tmperature in in the Kisselbach area was decreased by latent heat of evaporation, while relative humidity incrased. Latent heat effect was particularly influential in the dry inhaled air case. The latent heat is one of the key factor of temperature and humidity adjustment function.

The breath is a unsteady phenomena that consist of inhalation and exhalation. The nasal cavity simulation under unsteady condition was examined. A little unsteady chracteristic of nasal cavity flow was observed. However, the nasal cavity simulation under steady condition is possible to examine flow, temperatue and humidity in the nasal cavity.

Moreover, the several nasal cavities was simulated to examine individual characteristic of nasal cavity. The difference flow, temperature, humidity distribution was not observed between several nasal cavity.

The physiological function of paranasal sinus was examined by computational fluid dynamics (CFD). In this examination, the maxillary sinus that have the largest volume

in the paranasal sinus was forcused. The flow, temperature and humidity was examined by CFD. The difference of flow, temperature and humidity in the nasal cavity was not observed. It is assumed that the maxillary sinus has not supporting function for heat and humidity adjustment.

Key Words: **Nasal Cavity Simulation, Nasal Cavity Wall Model, Latent Heat,Temperature, Humidity, Computational Fluid Dynamics**