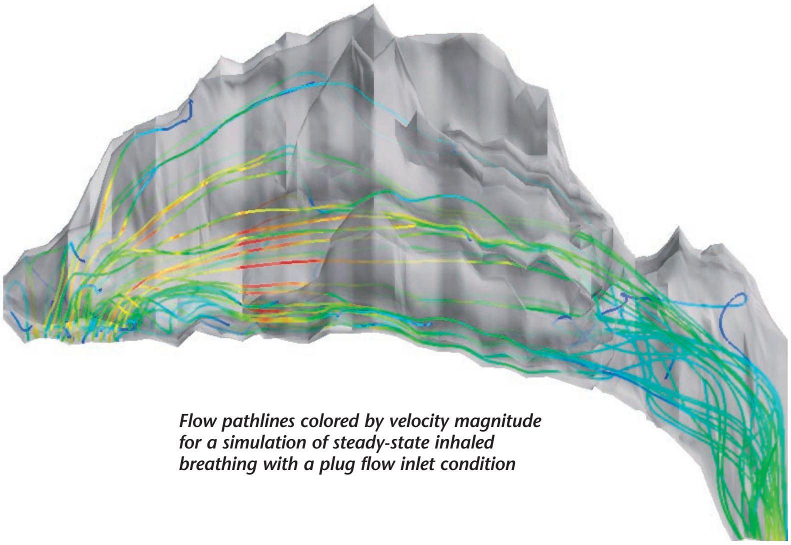

Flow pathlines colored by velocity magnitude for a simulation of steady-state inhaled breathing with a plug flow inlet condition

Locating the Nasal Valve with FIELDVIEW®

By R.A. Segal, J.M. Sheppard, J.S. Kimbell, CIIT Centers for Health Research, Research Triangle Park, NC

At the CIIT Centers for Health Research (CIIT), FIDAP is being used to model airflow in the human nasal passageways. Computed airflow patterns are used to simulate gas uptake and particle transport to determine the potential toxicological risk of inhaled materials. The accuracy of the nasal airflow predictions are tested by constructing a hollow plastic replica of the nasal cavity using stereolithography, a rapid prototyping process, and comparing simulated pathlines with dye streaklines in the hollow mold.

Another way to test model accuracy is to compare simulated nasal pressure drop and resistance with measurements made in people. Most of the nasal resistance measured in people has been reported in the vicinity of the nasal valve, an area near the front of the nose where the cross-sectional area of the airways is smallest. However, the nasal valve is difficult to locate because its exact location is different in each individual. An approximate location can often be found, however, using acoustic rhinometry (AR), a noninvasive process that calculates the nasal cross-sectional area and volume as a function of distance into the nose by acoustic reflections from a hand-held wand placed against the nostril.

Last year, a summer intern at CIIT was assigned the task of locating the nasal valve in a FIDAP model using FIELDVIEW. To do this, planes at different tilts were swept through the nasal model, and the resulting cross-sectional area on each plane was calculated. The intern was able to organize the search using FIELDVIEW's scripting language, FVX, to compute cross-sectional areas throughout the nasal model. By using the iso-surface definitions and the integration tool, she was able to sweep through the model with planes at various angles. To validate the procedure, the cross-sectional areas were compared to those acquired from AR measurements of the corresponding stereolithography mold.

Using AR, measurements were made on the right and left side of the hollow plastic nose independently. The thresholding abilities of FIELDVIEW were used to isolate the different sides in the model. The sweep plane for calculating cross-sectional area was allowed to tilt from left to right as well as front to back because the positioning of the AR wand may not be perpendicular to the airspace and therefore may select a minimum plane whose orientation is not straight. FIELDVIEW was useful because it allowed automation of this task by looping through sweep planes with different definitions. The data were continuously output during the running of the script so that analysis of the numbers could take place as the computations were progressing.

This process allowed the location of the nasal valve to be found in a systematic and reproducible way. In addition, the results compared fairly well with the AR data calculated from the stereolithography model. This information provides credibility for the nasal models developed at CIIT, and helps build the interface between measurements made on people in clinical settings and simulations of biological systems. ■

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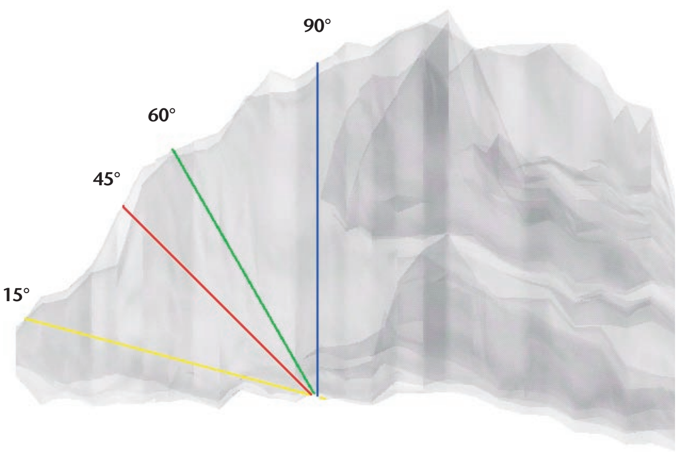
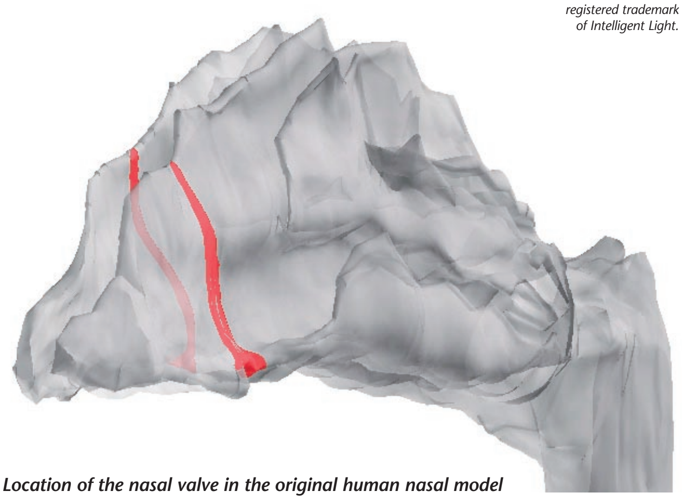


Orientation of several sweep planes used for locating the nasal valve



Location of the nasal valve in the original human nasal model