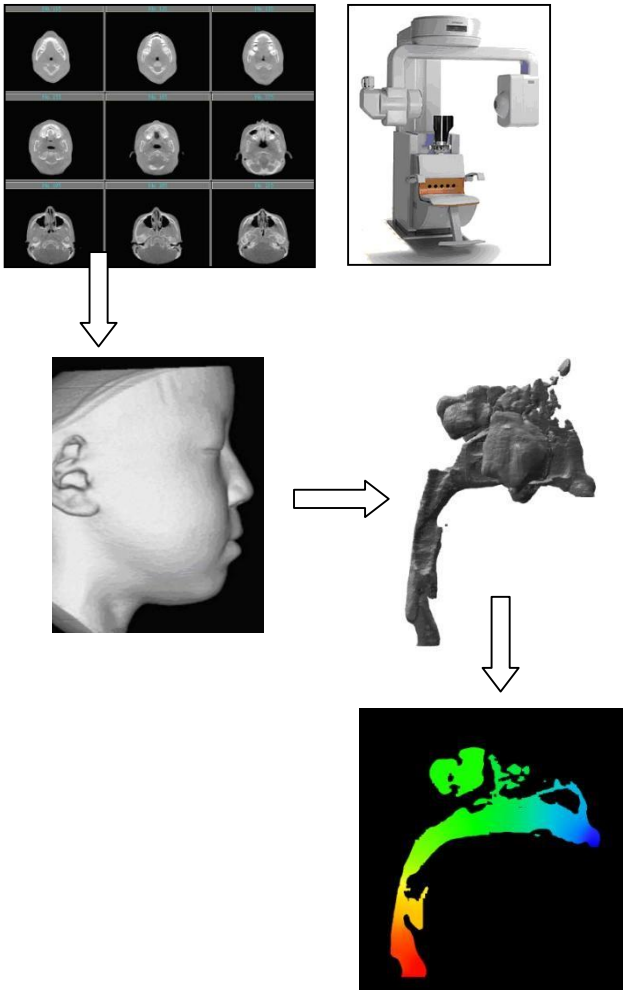
Simulation of Turbulent flow to Estimate Virtual Airflow Patterns in the Upper Airway by Tomonori Iwasaka of Kagoshima University Graduate School, Medical & Dental Sciences submitted by Zuwei Kong of CHAM Japan

This research simulates turbulent flow to estimate virtual airflow patterns in the upper airway. Volume rendering software (INTAGE Volume Editor, KGT, Tokyo, Japan) was used to create the 3-D images of the shape of upper airway. The rendered volume data was in a 512×512 matrix with a voxel size of 0.377 mm. The 3-D CBCT images for the airway model were exported to computational fluid-dynamic software (PHOENICS, CHAM-Japan, Tokyo, Japan) in stereolithographic format.

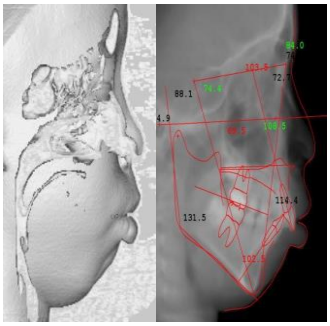


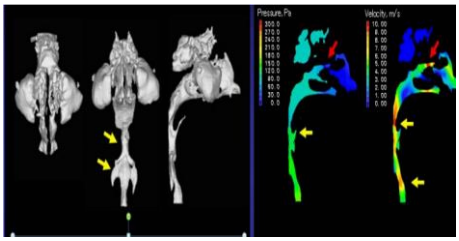
Airway resistance is greater during expiration than inspiration during quiet breathing. Accordingly, each voxel on the plane of the hypopharynx was considered part of the flow inlet while each voxel at the entrance of each nostril was considered part of the flow outlet. The air was assumed to be a Newtonian, homogeneous, and incompressible fluid. Elliptic staggered equations and the continuity equation were used in the study. The following boundary conditions were set to the model:

1) The air flowed perpendicular to the lower pharyngeal plane had a velocity of 200 ml/sec.
2) The wall surface was non-slip.
3) The simulation was repeated 1000 times to calculate the mean values. Convergence was judged by monitoring the magnitude of the absolute residual sources of mass and momentum, normalized by the respective inlet fluxes.

The iteration was continued until all residuals fell below 0.2 %.The results of the FMS are shown as pressure and velocity. The maximum pressure and the maximum velocity of the upper airway were calculated to evaluate the ventilatory condition and to detect obstructions in the upper airway.

Case result picture:





Reference:

Iwasaki T, Hayasaki H, Kanomi R, Saitoh I,Yamasaki Dental influences of upper airway obstruction on facial skeletal morphology in children with use of fluid mechanical simulation. Pediatric Otorhinolaryngology Japan. 2009. 30(1): 5-9.