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CROSS FLOW PHENOMENON IN NASAL SEPTAL PERFORATIONS

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ABSTRACT

Nasal septal perforation is an anatomical defect in the septum of the human nose. It is typically due to septal submucous resection and is usually caused by blunt trauma, inhalatory drug abuse, septal surgery such as septoplasty, and excessive nose picking and many other caurses[1-3]. Nasal septal perforation is usually associated with a wide variety of symptoms such as nasal obstruction sensation, epistaxis, crusting, dryness, headache, nasal pain, and whistling. The severity of perforations can be classified into asymptomatic, small symptomatic (smaller than 2 cm in diameter), and large symptomatic (larger than 2 cm in diameter)[3]. There are numerous reported studies and clinical case studies on the surgical treatments[1-6]. However, there are relatively fewer reported studies on the effects of septal perforations on the nasal airflow.

In this paper, we use Computational Fluid Dynamics (CFD) tool to simulate three different sizes of septal perforation in front of inferior turbinate, namely small hole of 5 mm diameter, a medium size hole of 10 mm and a slightly larger hole of 15 mm diameter. The holes are artificially created in the septal region near the middle turbinate of a nasal cavity model which has been earlier reconstructed from the MRI scan of a healthy patient without the septal perforation. The segmentation was performed using MIMIC version 11.

The simulation outcome revealed that with the existence of the septal perforation, there will be bi-directional cross flow appear through the hole. Maximum velocity and shear stress always occur at the downstream regime of the septal perforation (Figures 1 and 2 for the case of inhalation), and could potentially cause bleeding at that particular region. During breathing process, there is flow exchange through septal perforation, from

nostril side with higher flow rate to lower rate. As the size of the septal perforation is decreased, the percentage of flow exchange is also reduced accordingly, from 11% to 4% (for inhalation case). Surprisingly, this flow exchange through nasal separation is always higher during the inhalation process, which contributes to about 11 -4% of total flow rate for different perforated size, as compared to the exhalation process which would have about 6% to 2% of total flow rate for three different sizes. As the perforated size is decreasing (from 15m to 5mm),

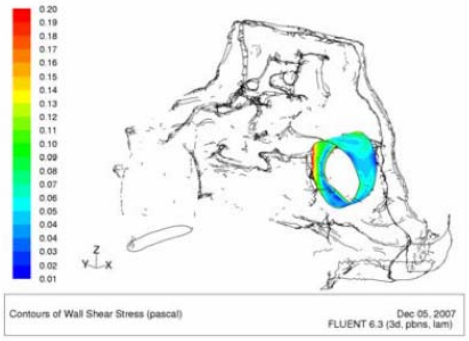

Figure 1 velocity profile

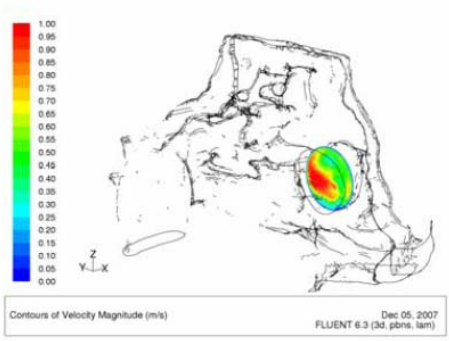

Figure 2 wall shear stress profile

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