A Prototype Endoscopic Sinus Surgery Simulator to Optimize Surgical Outcomes

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Introduction

Millions of endoscopic sinus surgeries are performed annually worldwide, yet the outcomes are often variable. One reason is that predicting functional outcomes (e.g., nasal airflow) based solely on CT or endoscopy can be difficult. We have developed a virtual surgery planning (VSP) tool that can load any patient’s CT data and allow the surgeons to endoscopically remove obstructive tissue using both visual and haptic feedback. Pre-calculated airflow resistance, wall shear stress, pressure drop, and other variables are displayed on the anatomical views, to identify potential sites of obstruction. After each virtual surgery, changes of nasal airflow can be computed and the process reiterated until optimal result reached.

Materials and Methods

A trial was performed on four patients with nasal obstruction and confirmed olfactory losses. Their olfactory losses may involve obstructions that block the air/odor flow to the olfactory fossa (OF). Previous studies indicated that surgical removal of the polyps or other forms of obstructions often leads to olfactory improvement, but the outcome is highly variable. Using the VSP tool, a total of 12 isolated or combined procedures were performed that includes polypectomy, partial middle turbinatectomy (PMT), septal body reduction (SBR). A normative range was established based on 22 healthy controls.

Results and Discussion

Two patients showed no improvement in airflow to OF regardless of procedures performed, one of whom had normal OF airflow pre-surgery, indicating a likely sensorineural olfactory loss rather than conductive. For one patient, an isolated medial aspect PMT demonstrated the best outcome and was better than traditionally performed lateral PMT, while SBR worsened air/odor flow to OF. For the last patient, just a polypectomy restored OF airflow while adding PMT didn’t provide further benefit.

Conclusion

The results demonstrate that some patients may obtain maximum benefit with targeted approaches, while for some, surgical restoring OF airflow is impractical. This trial demonstrates the usefulness of a VSP system to optimize the preoperative surgical plan based on objective benchmarks.

Translational Impact: A valuable tool for personalized medicine.
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