INTRODUCTION

Targeting delivery of nebulized drug into the maxillary sinuses is a main issue to improve clinical outcomes in patients with sinus disorders. To enhance the drug deposition in sinuses, the impact of 100 Hertz (Hz) acoustic frequency airflow, airborne particle size and breathing features were investigated using a realistic replica of the nasal cast. This replica was obtained from a fully validated (anatomically and geometrically) plastinated model created in our laboratory with a well-known aerodynamic comportment.

METHODS

1) Nasal cast replica
- Human oral airways segmenting from high resolution computed tomography (CT) scan images
- Rapid prototyping technology → realistic replica of the airways
- CT scan to ensure high quality fabrication
- Anatomical and geometrical validation using several techniques such as endoscopy

2) Aerosol experimental setup
Using gentamicin as a marker, 168 experiments of intrasinusal drug deposition after nebulizations were performed on the nasal cast with various parameters:
- Breathing pattern
- MMAD
- Acoustic airflow

RESULTS

Based on visual scan comparison, nasal replica didn’t show significative anatomy difference to plastinated specimen. The results of intrasinus drug deposition clearly demonstrate that aerosol can penetrate into the maxillary sinuses. We confirmed that a 100 Hz acoustic airflow led to increase the deposition of drug into the maxillary sinus by a factor 2-3. Moreover we assessed the optimal 3 µm MMAD allowing a major drug deposition in the maxillary sinuses. Drug deposition differences were observed for the various breathing patterns.

CONCLUSION

Acoustic airflow, breathing mode and aerosol size lead to disparate drug deposition pattern confirming existence of specific transport mechanisms. We emphasized in this study that 3 µm aerosol inhalation with acoustic airflow could improve benefits of drug deposition for the patients. Moreover breathing pattern seems also to be an important factor.