Olfactory Drug Delivery

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Abstract

Nasal drug delivery offers advantages over other delivery methods such as intravenous administration and pills that are taken orally. In particular, the olfactory region, which is located at the top of the nasal cavity, is an ideal place to deposit medication intended for the central nervous system, as it allows a greater dosage to be administered. More established means such as oral pills and inhalers allow for a greater chance for medication to reach undesired areas such as the lungs or kidneys, which could risk adverse effects. This study aims to integrate a vibrating mesh nebulizer with an induction charging mechanism. Combined with e-field guidance, the induction charger could increase the amount of medication delivered to the olfactory region.

This project focused on experimental testing and design related to the development of an induction charger that would be compatible with a vibrating mesh nebulizer. The e-field aspect was tested using a dry-powder coating gun, electrodes, and a plastic nasal model to evaluate the effectiveness of the e-field guidance within the nasal cavity model. Various nebulizer models were tested to observe vapor deposition along the entirety of the nasal cavity and the olfactory area. Vapor deposits were evaluated using sar-gel colorimetry and weighing vapor deposits in the target areas. During both the dry powder and nebulizer trials, two breathing modes were simulated to see which demonstrated higher deposits to target areas within the nasal cavity: normal breathing and bidirectional; bidirectional mimics the behavior of the nasal passage as the soft palate closes during exhalation through the mouth. The prototype for the charging tank was designed in NX9 and assembled via 3D printing. Dry-particle deposition trials indicated that increased voltages, positioned closer to the olfactory region, generated greater deposition rates. The ideal voltages tested were 21.5 V, 30V, and 70V. Bidirectional dry-particle tests, without the use of an electric field, yielded a 5% deposition rate in the olfactory region. In comparison, the incorporation of e-field guidance resulted in increased deposits to a range of 14-18%. Normal breathing dry-particle tests yielded depositions of approximately 1%. Nebulizer trials indicated that the Pari Sinus and Voyager Pro models yielded the highest vapor deposits. Bidirectional breathing produced greater deposition in the olfactory region when compared to normal breathing. These results corresponded to the dry particle tests. The current findings suggest that a combination of bidirectional breathing and e-field guidance could lead to more efficient drug delivery devices. It could also translate into reduced costs and waste associated with medications intended for the central nervous system.