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Simulation of magnetic drug targeting through tracheobronchial airways in the presence of an external non-uniform magnetic field using Lagrangian magnetic particle tracking

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Drug delivery technologies are an important area within biomedicine. Targeted drug delivery aims to reduce the undesired side effects of drug usage by directing the active agents near a desired site within the body. Recently, inert superparamagnetic iron oxide nanoparticles added to the nebuliser solution were used to guide aerosol to the affected region of the lung by means of a strong external magnetic field. A range of therapeutic agents, including genes, could be packaged for delivery by this technique. Herein, a numerical investigation of magnetic drug targeting (MDT) using aerosol drugs named polystyrene microparticle (PMS40) in human airways is presented considering one-way coupling on the transport and capture of the magnetic particle using a realistic 3D geometry based on CT scan images. An external non-uniform magnetic field is applied to deliver the aerosol magnetic drug career to specific region. Parametric investigation is conducted and the influence of particle diameter, magnetic source position, and magnetic number (Mn) on the deposition efficiency and particle behavior is reported. According to the results, the magnetic field increased deposition efficiency of particles in target region and the efficiency of deposition. The results also indicate that, the MDT technique has a direct relation with particle diameter increase for magnetic number of 1 Tesla (T) and lower ( ). Also there is an inverse relation between the particle diameter and deposition efficiency when Mn is more than 1 (T). Finally we could determine appropriate properties of the magnetic drug career size and the magnetic source characteristics.

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CFD simulation of airflow behavior and particle transport and deposition in different breathing conditions through the realistic model of human airways

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In this work, the airflow behavior and particle transport and deposition in different breathing conditions such as light breathing condition (i.e. 15 L/min), normal breathing condition (30 L/min) and finally the heavy breathing condition (i.e. 60 L/min) are investigated numerically. The realistic geometry data was reconstructed from CT-scan images of the human airways with 0.5 mm thickness of slices. The CT-scan images are imported in the 3D-DOCTOR and all slices were segmented. Then, the output has been imported in CATIA-V5 software. Finally, face, volume, mesh and extension tubes at inlet and outlets were created and then imported into ANSYS FLUENT 15. The Lagrangian approach is used to evaluating the transport and deposition of inhaled micro-particles. The presented results showed that for dp=5 μm and 10 μm, when flow rate=30 L/min and for dp=1 μm, when flow rate=15 L/min, the particle deposition fraction has the maximum amount. For flow rate=15 L/min and 30 L/min, the maximum deposition occurs in the zone number 1 and for flow rate=60 L/min occurs in the zone number 4. Also, the maximum pressure distribution happens when flow rate=60 L/min which would be acceptable. According to the results, the particles tended to go to the right branch and the minimum number of particles crossed the zone numbers 6 and 11.

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