A NUMERICAL SIMULATION OF PRESSURIZED INTRAPERITONEAL AEROSOL CHEMOTHERAPY (PIPAC): VALIDATION PART

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1. INTRODUCTION

Pressurized IntraPeritoneal Aerosol Chemotherapy (PIPAC) is a new and innovative drug delivery method developed to treat peritoneal metastasis using laparoscopy. The aerosol distribution by PIPAC, however, is not homogeneous and therapy may need optimization for the individual patient, given the variability in PM. A homogenous aerosol distribution in the area of interest is therefore a goal in PIPAC. We therefore started modeling PIPAC with a computational fluid dynamics (CFD) method to understand and optimize particle deposition. In this study, we aim to validate the CFD model by comparing the calculated results with in-vitro PIPAC experiments in a box model.

2. MATERIALS AND METHODS

Experiments were performed in the Experimental Surgery Lab using a Plexiglas box model. The box size was 185 x 135 x 152 (mm) and it was infused by CO2 gas maintained at a pressure of 12 mmHg. Black ink was used in the experiment, injected through a nebulizer and high-pressure injector, where the experiment was repeated for six times. Tissue was placed on four plates inside the box (A, B, C and D) to allow us to visualize and quantify the distribution of ink. The CFD geometry model was generated by COMSOL Multiphysics. The same procedures as the experiment were considered: insufflating CO_2 into the box to reach 12 mmHg pressure. CFD Module was applied under initial and boundary conditions (inlet flow with 12 mmHg and no-slip conditions for the walls). Then injecting a volume of 20 mL of black ink (density: 1071.9 kg/m^3, viscosity: 4.875*10^{-3} Pa.s) with a flow rate of 0.5 mL/s at a fixed injector position in the top surface was modeled.

3. RESULTS AND DISCUSSION

The results show the tissues after the experiment and comparison between the experimental and simulated distribution of ink over the 4 plates. An overall good agreement was observed between the calculated and the experimental results. Not surprisingly, most aerosol was deposited on the bottom surface due to the gravity. To overcome this problem, an electrostatic field can be imposed, yielding ePIPAC. This will be the topic of our future experimental and computational work.