P11.12. Velocity Profile Effects And Transillumination Sampling

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Indicator dilution theory (IDT) provides the underlying principles for many blood flow measurement techniques. However, researchers have raised concerns that the theoretical underpinnings of IDT do not apply to measurements made using transillumination (TI) sampling. In this work, we address some of these concerns by providing: (a) extensions of the TI theory to circumvent apparent limitations raised regarding the injection of the TI contrast agent, (b) mathematical theory which yields the form of the transport function between two TI curves in a straight tube subject to a steady power law velocity profile, (c) a novel numerical deconvolution procedure which exploits knowledge of the theoretical form of the transport function, and (d) examine the theory via computer simulation as well as its application to data acquired in a flowing cylindrical tube system with TI sampling via x-ray angiography. The mathematical theory and suggested numerical computations provide a beginning framework upon which flow and transit time calculations from TI sampled data may be based. Supported by Dept. Veterans Affairs, NHLBI HL-19298, and NSF BES 9818197.

P11.13. Measurements Of Upper Airway Resistance Before And After Distraction Osteogenesis Of The Mandible

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A retrospective study of upper airway resistance was performed on four pediatric patients with microretrognathia who underwent bilateral mandibular distraction. Archived CT data were used to compute increases in airway volume and to generate rigid hollow models of the upper airway pre- and post-distraction. These models were individually installed in an open-ended flow circuit instrumented for simultaneous measurements of volume flow-rate and pressure differential between the oral and tracheal sections. Two different configurations were required to simulate alternately inspiratory and expiratory flow directions. Flow resistance was calculated as the ratio of pressure drop to flow. Significant decreases in inspiratory and expiratory flow resistance (51% and 85%, respectively) were found in one patient who experienced a 71% increase in airway volume after distraction. Flow resistances did not change significantly in the other three patients whose airway volumes were increased by 20 to 31%.

P11.14. Autoregressive Model Based On Third Order Statistics For Characterizing Cough Transmission Filters

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An autoregressive model based on third order statistics was used to characterize the transmission filter during a cough recorded by a recording system (Goldsmith, et al., Proceedings 3rd International Workshop on Biosignal Interpretation, 1999) from subjects awaiting pulmonary function testing at the West Virginia University Hospital. Because the respiratory tract changes shape with respect to the excitation with time, it can be modeled as a time-varying filter with fixed parameters over short time intervals. In order to determine the filter characterisitcs, cough samples were processed through an all-pole digital filter created with an autoregressive routine (Iyer, et al., IEEE Transaction of Biomedical Engineering, 1989) based on third order cumulants (Hadjileontiadis, et al., Technology and Health Care1997). Filter response was analyzed. The inverse filter was used to separate the excitation source. Coughs were analyzed from healthy control subjects, as well as patients diagnosed with obstructive and restrictive lung disease. Results showed differences between the group of control subjects and those with lung disease in both the characteristics of cough sound source and the sound transmission path.

P11.15. How Gas Trapping At Low Lung Volumes Affect Energy Required To Expand Lung To Total Lung Capacity?

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When an excised lung is slowly ventilated, not all gas entering the lung during inflation can be removed during the following lung deflation. In order to develop a realistic model of the gas trapping process, it is important to determine the mechanical characteristics of the region of the lung where gas trapping takes place. In this study, excised rat lungs were inflated-deflated from the degassed state for two cycles between 30 cm H_2O, defined as total lung capacity (TLC), and a minimum pressure of -5 cm H_2O (PLmin). Then the lungs were ventilated between 60% TLC and PLmin at a slow continuous rate for 10 inflation deflation cycles. During this procedure, trapped gas accumulated in the lungs. The lungs were then inflated to TLC and the increase in energy necessary to expand the lung compared to the second inflation-deflation cycle was determined. Results show that a significant increase in energy was required to expand the lungs containing trapped gas which accumulated as the lung was ventilated at low lung volumes when compared with the energy required to expand the lung during the second inflation-deflation cycle.

P11.16. Flow-Independent Nitric Oxide Exchange Parameters In Healthy And Mild Asthmatics

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Exhaled nitric oxide (NO) is a potential non-invasive index of airway inflammation. To determine the role of NO in mild asthma, we estimate three key flow-independent parameters (maximum flux of NO from the airways ($J_{NO,max}$, pl/s), diffusing capacity of NO in the airways ($D_{NO,air}$, pl· s^{-1}· ppb^{-1}) and steady state alveolar concentration ($C_{alv,ss}$, ppb)) in a group of 18-31 year-old adults [healthy controls, n=9; patients with mild asthma, n=9] at baseline (pre), post 10-minute exercise challenge (Pex) at 80 of predicted maximum heart rate, and post bronchodilator (combivent) inhalation (Pbd). The population mean values are summarized in the Table. Estimated $C_{alv,ss}$ does not differ significantly among each group and between controls and asthma; however, baseline $D_{NO,air}$ and $J_{NO,max}$ are elevated in asthma. In addition, $D_{NO,air}$ significantly increased after exercise. We conclude that increased $D_{NO,air}$ and $J_{NO,max}$ may provide greater sensitivity in distinguishing patients with mild asthma from healthy controls. (NIH grant HL 60636)

P11.17. Computational Modeling Of Sound Generation And Propagation In The Human Lung

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A three-dimensional parallel supercomputer model is developed to simulate normal breath sound generation and propagation in the human lung. The breath sounds are generated by solving Lighthill's equation for sound generation from complex vortices. The vortex flow is obtained from the solution of the incompressible Navier-Stokes equations. Initially, an asymmetric single bifurcation geometry model of the airways is used for the flow simulations. Sound propagation through the surrounding lung parenchyma is simulated by solving the inhomogeneous wave equation. For the sound propagation simulations, the tissue density distribution for a stationary thoracic model is obtained from the Visible Human CT data. Preliminary sound propagation simulations based on an artificial sound source indicate that even slight variations in tissue density can drastically alter the received sound at various chestwall locations. These simulations also confirm previous experimental studies that sound propagation is asymmetrical due to the inherent asymmetry of the lung.

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