Title : COMPUTED TOMOGRAPHIC STUDY OF ANESTHESIA INDUCED PULMONARY CHANGES IN PRIMATES

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Introduction: Computed Tomography (CT) is a widely used method for examining the lungs. To date it is the most sensitive method of detecting pulmonary metastases. General anesthesia (GA) is often required in children to prevent movement artifacts during the CT scan. It has been suggested that GA may produce pulmonary changes which may be misinterpreted as pathological lesions (1). We have developed a primate model to study this phenomenon and to define the underlying physiologic mechanisms.
Methods: Ten Rhesus monkeys (Macaca mulatta) were screened by chest x-ray and/or thoracic CT. Four with pre-existing lung disease were excluded. These four animals were found to have lung mites at autopsy. Six were chosen for further study. Intramuscular ketamine and atropine were used for sedation during all the procedures. Studies were performed on a General Electric 9800 CT scanner with a two second scan time.
Results: The monkeys were scanned after intravenous thiopental (pentothal, 4 mg/kg body weight) and orotracheal intubation with spontaneous ventilation. In eight out of nine experiments, pulmonary changes were observed as small radio-opacities predominantly in the posterior portion of the lung bases below the level of the carina and located in the periphery of the lungs. In four of the animals the anesthesia was continued with N_2O and O_2 (50:50) and halothane (1-2%) with positive pressure ventilation at approptiate tidal volumes (10ml/kg body weight). This resulted in partial clearing of the pulmonary radio-opacities. Addition of positive end expiratory pressure (PEEP 10cm H_2O) in two animals resulted in further clearing. Complete resolution was seen only when positive pressure ventilation with high tidal volume was employed.
Discussion: The pulmonary changes seen with GA and orotracheal intubation may be due to fall in functional residual capacity (FRC) with consequent airway closure. Intrapulmonary shunting and cephalic shift of diaphragm may also play a role in the production of these changes (2). Conventional x-ray examination does not show any changes indicative of atelectasis during uncomplicated anesthesia. The high spatial and contrast resolution of CT permitted the demonstration of alterations in the dependent regions of the lungs. This supports the theory that the physiologic changes seen during anesthesia and artificial ventilation are due to alveolar collapse. The pulmonary changes noted are indistinguishable from those secondary to metastatic foci in the lungs. Therefore, there is a great danger of misdiagnosing or overstaging a patient's disease. We have shown that induction of anesthesia with thiopental and orotracheal intubation induces changes in the lungs. These changes cleared partially with positive pressure ventilation and application of PEEP. They resolved completely with the use of high tidal volumes.

We have drawn the following conclusions from this study. First, this model can be used to study the effects of various aspects of GA on the lungs. Second, ketamine alone does not produce any changes. Third, for CT in children who cannot be sedated by conventional methods, ketamine should be used rather than general anesthesia. Fourth, when GA is used during scanning, high tidal volumes should be employed to clear the pulmonary changes induced by general anesthetics and intubation.

References: 1. Damgaaard-Pedersen KJ, Quist T: Pediatric pulmonary CT scanning: Anesthesia induced changes. Pediatric Radiology 9:145-148, 1980
2. Froese AB, Bryan AC: Effects of anesthesia and paralysis on diaphragmatic mechanics in man. Anesthesiology 3:242-255, 1974