Title: REDUCED FRC IN ANESTHETIZED INFANTS: EFFECT OF LOW PEEP


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Introduction. General anesthesia, with or without muscle relaxants, is associated with a significant reduction in resting lung volume (functional residual capacity, FRC) in healthy young adults (1). It is probable that infants and young children under general anesthesia are particularly prone to airway closure and to ventilation/perfusion imbalance since static recoil pressure of the lung (Pstl) is extremely low (compliance, high) in the developing lungs (2). Such information on FRC in infants and children has not been available. Furthermore, if this is the case, a low level of positive end-expiratory pressure (PEEP) would have a beneficial effect by restoring FRC and improving the distribution of ventilation. The purpose of the present investigation was to examine such possibilities as part of clinical assessment and management of infants and children undergoing general endotracheal anesthesia for elective surgery. Data from those undergoing thoracic or upper abdominal surgery were not included.

Methods. Twenty-nine patients between the ages of 3 days and 8 years were studied under halothane-N2O or narcotic-N2O-relaxant anesthesia. Approximately 30 minutes after the induction of anesthesia, the patient was rebreathed for one minute with a bag containing 50 ml/kg of approximately 10% helium (He) and 90% O2. The concentration of He was measured before and after the period of rebreathing with a mass spectrometer. FRC was calculated from He dilution and was expressed as percent of predicted values in awake subjects (3,4,5). The FRC measured with this technique was the volume of gas in the airspace which was in direct communication with the airway system. It did not include the volume of gas which was trapped behind the closed airways. When the FRC thus determined was less than 70% of predicted values, a PEEP of 5 cm H2O was added to the anesthesia circuit. In these patients the measurement of FRC was repeated approximately 30 minutes later. In some patients FRC was measured again after the low level of PEEP was removed. Whenever the patient had an arterial line in place for clinical management, FRC data were correlated with blood gas values.

Results. The average FRC (% predicted) under general anesthesia for patients between 1 and 8 years of age (n=17) was 58.7 ± 5.1 (SEM) which was significantly (p<0.001) reduced from predicted values. In infants less than one year of age (n=12), the reduction in FRC was marked (38.5 ± 5.2; p<0.001). The difference in the extent of reduction in FRC between the two age groups was highly significant (p<0.001). With the addition of PEEP with an adjustable PEEP valve in 16 patients, there was a consistent increase in FRC toward predicted values. The average increase in FRC was 28.3 ± 6.0% of predicted FRC values above those obtained without PEEP (p<0.001). In 5 infants (age: 2-5 months), in whom serial arterial blood gases were available, as part of clinical management, the average A-aO2 was 132 ± 20 torr without PEEP while alveolar ventilation was adequate. With the addition of PEEP it decreased to 68 ± 11 (p<0.05) without changes in PaCO2. In 2 infants without PEEP, PaO2 was found to be in the hypoxic range (58 and 60 torr, FIO2=0.35). The addition of PEEP, PaO2 increased to 158 and 147 torr, respectively.

Discussion. Current studies clearly demonstrate that general anesthesia is associated with a marked reduction in FRC in infants and children of all ages but particularly in infants below one year of age (5). Such a reduction in FRC would be associated with premature airway closure and would result in ventilation/perfusion imbalance. Indeed, A-aO2 was markedly increased in all infants in whom blood gas data were available. Some infants were found to be hypoxic under conventional FIO2 and adequate alveolar ventilation. A low level of PEEP restored FRC toward normal values probably by preventing premature closure of small airways. Such a restoration of FRC was associated with a marked reduction in A-aO2 by improving the distribution of ventilation and regional ventilation/perfusion balance. Thus, the routine use of low PEEP is recommended for general anesthesia in infants and children. Theoretically, infants are more susceptible to airway closure than older children and young adults since Patl in infant's lungs is exceptionally low as in the emphysematous lungs of the aged (2). In addition, extremely compliant thoracic wall in infants would make them more prone to further reduction in FRC. Such a physiological difference between infants and older children was apparent in the current investigation in terms of a difference in the extent of reduction in FRC.

References.

(Supported in part by USPHS grants: HL21444, HL25810)