consisted of a respiratory rate of 30 breaths/min, an inspiratory time of 0.6 s, an inspired oxygen fraction of 1.0, and a peak inspiratory pressure of 25 cmH_2O that included a positive end-expiratory pressure of 5 cmH_2O. Arterial blood gases were subsequently measured at 15, 30, 60, 90, and 120 min.

PLV Technique

Partial liquid ventilation was performed using room temperature FC-77 (30 mL/kg, 3M Company, St. Paul, MN, USA) to fill the functional residual capacity of the rats. Filling was begun immediately on completion of the tracheostomy while the ventilator was briefly disconnected from the endotracheal tube. Filling was completed in 1 min and then the ventilator was reconnected. To compensate for evaporative losses from the liquid functional residual capacity, supplemental FC-77 was administered hourly (4 mL/ kg/h).

Surfactant

Survanta (Abbott Laboratories, North Chicago, IL, USA) is a natural bovine lung extract containing 25 mg/mL phospholipids, 0.5-1.75 mg/mL triglycerides, 1.4-3.5 mg/mL free fatty acids, and less than 1.0 mg/mL protein. The surfactant was instilled intratracheally at total phospholipid doses of 50 mg/kg and was administered to the animal's lungs as a bolus while the animal's body was being rotated. Five-milliliter syringes were used to administer the surfactant. The syringes were connected to the tracheal tubes of the animals, and the surfactant was administered first, followed by the administration of air.

Deflation Pressure-Volume Curve Measurements

After 120 min of ventilation, each animal was deeply anesthetized with an intraperitoneal injection of pentobarbital (100 mg/kg) and exsanguinated via the abdominal aorta. In the PLV and surfactant + PLV groups, as much FC-77 as possible was allowed to drain passively before performing pressure-volume curve measurements. A deflation pressure-volume curve was obtained by inflating the lungs with air to 25 cmH_2O for 1 min and recording the maximal lung volume. Pressure was then progressively lowered and held for 30 s at 20, 15, 10, 5, and 0 cm H_2O with lung volume measured at each pressure. The measured volumes were corrected for air compression within the measurement system and expressed as mL/kg body weight.

Histological Analysis

Postmortem, the heart and lungs were removed en bloc and stored in 10% formalin. Analysis was performed on the left lung of each animal. Samples were processed and stained with hematoxylin and eosin. A pathologist blinded to the treatment group of animals performed a histopathological examination of the lung tissue. Sections were examined by light microscopy and assessed for the presence of hyaline membranes, hemorrhage, intra-alveolar edema, and neutrophil accumulation. The neutrophil counts per high-power field (hpf) (× 400) in 10 randomly selected fields of a lung specimen for each animal were carried out, and the mean neutrophil count per hpf was determined for each group.

Statistical Analysis

Data are presented as the mean ± SEM. Statistical analyses were performed using the SPSS statistical software package, vers. 10.0 for Windows (SPSS, Chicago, IL, USA). Statistically significant differences were analyzed by Kruskal-Wallis tests. Between-group comparisons were made by Mann-Whitney U tests. Significance was accepted at $p < 0.05$.

RESULTS

Effects on Gas Exchange

Figure 1 illustrates the changes in arterial blood gases after the initiation of ventilation. Pretreatment oxygen tension in arterial blood (PaO_2) at time 0 was around 80 mmHg for all 4 groups (Fig. 1A). Mean PaO_2 deteriorated gradually after 15 min of ventilation in rats without treatment. By contrast, PaO_2 increased significantly following the first 30 min of ventilation in the surfactant, PLV, and surfactant + PLV groups ($p < 0.05$). Oxygenation was maintained during the study period in the surfactant group, and values were significantly higher than those of rats with no treatment or PLV at 60,