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Short communications

Effects of lumbar puncture position on arterial blood gases

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Abstract: We observed the changes in partial pressure of arterial oxygen (Pao_2) and carbon dioxide ($Paco_2$) before and during assumption of the lateral position prior to lumbar puncture in 81 patients to investigate whether lung volume decreased and ventilation was suppressed. Pao_2 significantly decreased while the patients were in the lateral position, while $Paco_2$ remained unchanged. There was a negative correlation between the change in Pao_2 and age [change in Pao_2 (mmHg) $= -0.13 \times$ age (years) $+ 4.28$, $P < 0.01$]. The fact that closing volume increases with age implies that the decrease in functional residual capacity in the lateral position could have caused the decrease in Pao_2. It is therefore advisable to continuously monitor arterial oxygenation using a noninvasive monitor, such as a pulse oximeter, while performing spinal or epidural block, especially in elderly patients.

Key words: Lateral decubitus position, Pao_2, Againg

When performing spinal or epidural block, patients must be in the lateral decubitus position and keep their trunks bent forward. Although the lateral decubitus position does not per se decrease lung volume [1] and does not change the ventilation-perfusion ratio (V/Q) [2], it seems reasonable to expect an acutely bent position to decrease lung volume or suppress respiratory movement. Furthermore, it is well known that premedication for anesthesia, such as midazolam, produces respiratory depression [3,4]. The aim of this study was to investigate the changes in partial pressure of arterial oxygen (Pao_2) and carbon dioxide ($Paco_2$) before and during lumbar puncture position in patients who required spinal or epidural block for surgery.

This study was approved by the Sapporo Medical University Committee on Human Research, and informed consent was obtained from each patient. Eighty-one ASA physical status I or II adult patients who were scheduled for spinal or epidural block for surgery on the lower abdomen or a lower extremity were included in the study. Patients with a history of pulmonary dysfunction were excluded from the study. The mean age and weight were 53.1 years (range 16 to 92 years) and 60.2 kg (range 38 to 114 kg), respectively. The patients were premedicated with 30–60 μg/kg of midazolam and 0.4–0.5 mg of atropine, im, at 45 min before surgery.

In the operating room, peripheral venous and radial arterial catheters were inserted, the former for infusion of lactated Ringer's solution (5 $ml \cdot kg^{-1} \cdot hr^{-1}$), and the latter for blood gas analysis. Peripheral oxygen saturation (Spo_2) at the left second finger was monitored using a pulse oximeter (Pulsox-7, Minolta, Tokyo, Japan). After the values of Spo_2 had reached steady state while the patients rested in the supine position, Pao_2 and Pco_2 were measured using a gas analysis apparatus (Ciba-Corning 288, Ciba-Corning, Medfield, USA). Next, the patients were turned to the lateral decubitus position and asked to bend their trunks as far forward as they could. After the values of Spo_2 had reached steady state, Pao_2 and $Paco_2$ were again measured.

Comparisons were made between levels of Pao_2 and $Paco_2$ at the supine and lateral positions, and between change in Pao_2 (ΔPao_2) and the other factors [age, body mass index (BMI), and change in $Paco_2$ ($\Delta Paco_2$)]. For the former, Student's t-test was used and $P < 0.05$ was considered statistically significant; for the latter, linear regression analysis was used to check for correlation between ΔPao_2 and the other factors; $r > 0.40$ was considered statistically significant. Results are expressed as mean ± SD in the text, and as scatter diagrams in the figures.

Pao_2 was significantly decreased from 85.1 ± 7.6 to 82.2 ± 9.9 mmHg (range of ΔPao_2; 8.7 to −17.6 mmHg)

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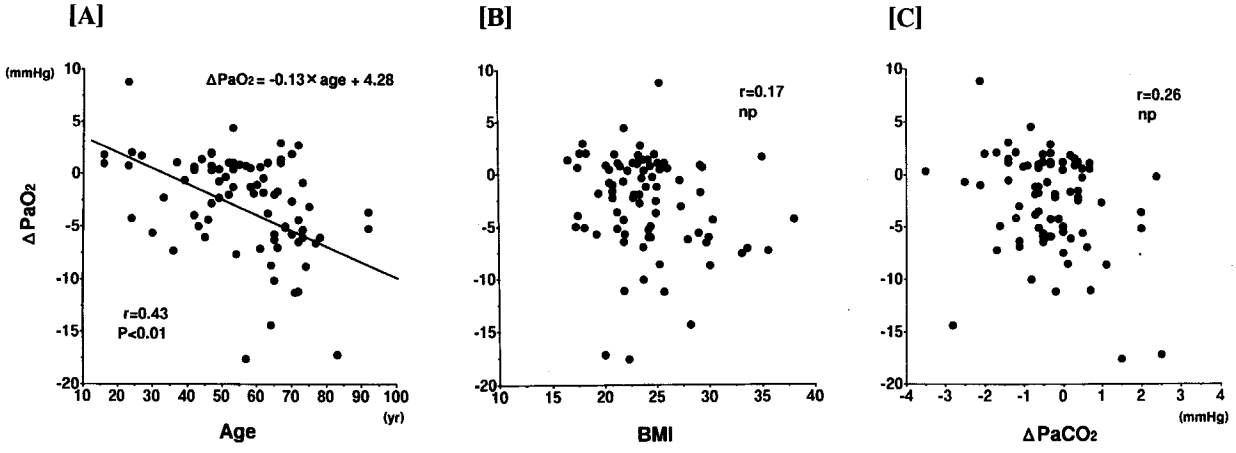

Fig. 1A–C. The relationship between the change in Pao_2 (ΔPao_2) and age, body mass index (*BMI*), or the change in $Paco_2$ ($\Delta Paco_2$). **A** There was a negative correlation between ΔPao_2 and age [ΔPao_2 (mmHg) = $-0.13 \times$ age (years) + 4.28; $P < 0.01$]. **B** No correlations, however, were observed between ΔPao_2 and BMI, or **C** $\Delta Paco_2$.

after the patients took the lumbar puncture position ($P < 0.01$), while $Paco_2$ remained unchanged (38.7 ± 2.5 to 38.5 ± 2.8 mmHg). The relationships between ΔPao_2 and age, BMI, and $\Delta Paco_2$ are shown in Fig. 1. There was a negative correlation between ΔPao_2 and age [ΔPao_2 (mmHg) = $-0.13 \times$ age (years) + 4.28; $P < 0.01$, Fig. 1A]. No correlations, however, were observed between ΔPao_2 and BMI (Fig. 1B) or $\Delta Paco_2$ (Fig. 1C).

The main finding of the present study was that Pao_2 significantly decreased once the patients had assumed the lateral position, while $Paco_2$ remained unchanged. Rehder et al. [1] reported that the change from the supine to the lateral decubitus position per se resulted in a significant increase in functional residual capacity (FRC). In the lateral position in the awake patient, the lower lung is ventilated preferentially over the upper lung, regardless of the side on which the patient is lying [5]. Since there is greater perfusion to the lower lung, the preferential ventilation to the lower lung is matched by its increased perfusion, so that the distribution of V/Q of the two lungs is not greatly altered when the subject, if awake, assumes the lateral decubitus position [2]. Therefore, it is difficult to justify the conclusion that the lateral position is primarily responsible for the decrease in Pao_2. Alveolar hypoventilation and/or the decrease in FRC due to the extremely bent position can be considered as a cause of the decrease in Pao_2. Alveolar hypoventilation, however, can be excluded from the reasons because no increase in $Paco_2$ occurred. Therefore, the decrease in FRC seems to be the most reasonable explanation for the decrease in Pao_2. This is strongly supported by the negative correlation between ΔPao_2 and age.

Closing volume, which is the lung volume at which airway closure occurs, increases with age [6]. Airway closure occurs in young, healthy individuals only when the lung volume is very low, close to residual volume; in elderly persons and in those with emphysema, owing to loss of elastic recoil, airway closure occurs at higher lung volumes and may occur during tidal breathing. An increase in closing volume and/or a decrease in FRC induces airway closure even during resting ventilation, which results in a decrease in Pao_2 [6,7]. Although the sedative dose of midazolam was not observed to affect alveolar ventilation in the lateral position in this study, it seems wisest to monitor the degree of arterial oxygenation continuously even during the performance of spinal or epidural block, especially with elderly patients because of the increasing vulnerability with age to hypoxia and because hypoxia is associated with the use of midazolam [8].

It was also revealed in this study that there was no correlation between ΔPao_2 and BMI. In obese patients, we had anticipated that Pao_2 might decrease because of the decrease in FRC due to high intraabdominal pressure, but gravity acting on the abdominal contents actually causes the FRC to decrease further [9], unlike the effect observed in the supine position. When obese patients are turned to the lateral decubitus position and asked to bend forward, they are released from the abdominal compression and FRC is maintained. This may be the reason why the change in Pao_2 with the obese patients was small.

In conclusion, Pao_2 significantly decreased with age in patients who lay in the lumbar puncture position. It is recommended to continuously monitor arterial oxygenation using a noninvasive monitor, such as a pulse oximeter, even during the performance of spinal or epidural block, especially with elderly patients.

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