Analysis of capnogram during patient-controlled sedation with propofol or midazolam in healthy volunteers

Jung-Man Lee¹, Kwang-Suk Seo², Hyun Jeong Kim²

¹ Department of Anesthesiology and Pain Medicine, Seoul Metropolitan Government-Seoul National University Boramae Medical Center, Seoul, Korea, Republic of

² Department of Dental Anesthesiology, Seoul National University Dental Hospital, Seoul, Korea, Republic of

Background

Despite being an important technique to prevent respiratory problems during sedation, capnography has some limitation in detecting respiratory depression. Thus, a more accurate capnography monitoring algorithm is needed. We analyzed capnograms obtained from the nasal cannulas of healthy volunteers during patient-controlled sedation (PCS) with propofol or midazolam.

Methods

- ◆ The study was approved by the IRB.
- ◆ Sixty healthy participants were randomly assigned to one of six groups, according to the drug and dose used in PCS.
- ◆ Digital data on the partial pressure of carbon dioxide before and during PCS were converted into analyzable waves.
- ◆ We calculated the capnographic inspiratory and expiratory times using the peak velocity of increasing and decreasing PCO₂.
- ◆ The ratio '[capnographic inspiritory time]/[capnographic expiratory time]' was defined as 'capnographic I:E ratio in this study.'
- ◆ We determined the capnographic I:E ratio before PCS began (before PCS) and during PCS while the participant was conscious or unconscious.
- ◆ Respiratory depression event was defined by the absence of waves in the capnogram for >30 s or an event of peripheral oxygen saturation <90%.
- ◆ We used LoFloTM CO₂ sampling O₂ delivery nasal cannula (Respironics Co. Inc, MN, US).
- ◆ We used the MATLAB® program for analysis of capnogram.

Figure 1. Process of calculatong capnographic I:E ratio using MATLAB program

Results

- ◆ Capnographic I:E ratio was lower during the 'unconsciousness during PCS' (mean: 0.93, 95% CI: 0.89-0.98) than it was in the 'before PCS' (1.10, 1.04-1.15) or 'consciousness during PCS' (1.09, 1.03-1.15) ($p < 0.001$). [Figure 2]
- ◆ In 21 participants who experienced respiratory depression (RD), capnographic I:E ratios tends to disperse immediately before a RD event compared to the normal breathing period, as evidenced by the significantly higher average standard deviations during these events (during RD: 0.71 ± 0.69 , normal breathing: 0.17 ± 0.10 , $p = 0.002$) [Table]

Figure 2. Capnographic I:E ratio according to patient-controlled sedation and mental status

Table. Comparison of mean and standard deviation of capnographic I:E ratio between normal breathing status and respiratory depression (RD) status in 21 patients experienced RD

capnographic I:E ratio	during normal breathing	during RD	<i>P</i>
Mean	0.96 ± 0.24	1.02 ± 0.28	0.515
Standard deviation	0.17 ± 0.10	0.71 ± 0.69	0.002

Conclusion

Quantification analysis of capnograms could be used to improve diagnosis and prediction of respiratory depression and desaturation events and, therefore, could be a useful tool for monitoring patients during sedation.