Bispectral Index monitoring in Rats during Sevoflurane anaesthesia.

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Background and Goal of Study: Bispectral Index (BIS) monitoring is widely spread as a measure for evaluating the depth of anaesthesia in clinical settings. Although the analyzing of electroencephalogram (EEG) calculating BIS value was based on humans, some recent studies reported that BIS monitoring could be useful in animals including laboratory species. Rats are very popular animals in laboratory investigations as same as mice; however, there is scarce information of BIS monitoring in rodents. Thus, we evaluated the usefulness of BIS in awake and anesthetized rats during sevoflurane anaesthesia.

Material and Methods: 12 male SD rats weighing 220-240 g were used. The rats were briefly anaesthetized by inhalation of sevoflurane (3%) and were attached the 4 pierced electrodes on the head. Each rat was given recovery period at least 48 h. The electrodes were connected the leads immediately before the examinations. EEG signal was analyzed by Vista A-3000 (Nihon Kohden, Tokyo, Japan).

Each rat was anaesthetized with sevoflurane in a small box chamber. The concentration of sevoflurane was changed every 10 minutes and the concentration was randomly set at 0% (control), 2%, 3.5% and 5%. Every rat was received 6 period of sevoflurane anaesthesia (totally 1 h), and thereafter the inhalation was terminated. The BIS Index, spectral edge frequency 95% and amplitude were recorded after the equilibrium period (5 and 10 min) from the change in the concentration.

Results and Discussion: Before the induction of anesthesia, all animals were awaking and showed high values of BIS (96.4 ± 1.2). Following to the increase of the sevoflurane concentration, the BIS values were significantly decreased and the variance was increased (Table, Fig).

The significant and dose dependent relationships between the sevoflurane concentration and BIS values were observed. But, the accuracy of monitoring for the depth of anesthesia would not be fully acceptable in the present system.

Conclusion: Although there is a room for discussion to evaluate a depth of anesthesia using BIS monitor in animals, the current preliminary investigation firstly suggested a validity of BIS monitoring in rats during sevoflurane anaesthesia.

In our previous study (Anesthesiology 2016, A4232), a burst suppression pattern was not observed during anesthesia using both propofol and sevoflurane. We directly placed the electrode into the brain through the bar hole of the skull. This procedure could reduce the impedance of input, but too low impedance would not be acceptable for analyzing the signal and for deleting the noise. The BIS monitor was frequently trying to modify the dynamic range of sensitivity. This automatic and pre-programmed sequence might disturb to calculate processed electroencephalography.

In the current investigation, we developed a simple and realistic electrode, a piercing wire. We could not measure the actual impedance of electrode, however, the new device might be suitable for analyzing electroencephalogram.

There are few studies in a literature concerning to the availability of BIS for experimental animals. Until now, the measurement of BIS in many studies was limited during anesthesia. Whereas, we demonstrated that the perianesthetic change of BIS, from before the induction to after the recovery.

Table. The sevoflurane concentration and the values of Bispectral Index

Sevoflurane concentration	Bispectral Index	Spectral edge frequency 95 (Hz)	Amplitude
0%	96.4 ± 1.2 [93.3 - 97.7]	20.0 ± 3.6 [14.4 - 26.4]	9.2 ± 2.3 [6.4 - 14.2]
2%	76.7 ± 18.1 [29 - 95.6]	18.6 ± 3.9 [11.2 - 25.3]	10.3 ± 2.1 [6.8 - 17.7]
3.5%	51.4 ± 25.5 [11.9 - 97.3]	19.5 ± 4.8 [7.3 - 26.7]	12.5 ± 3.6 [7.0 - 22.9]
5%	38.8 ± 26.6 [1 - 95.6]	16.3 ± 6.3 [3.2 - 28.6]	11.6 ± 4.4 [5.8 - 26.8]

Data are expressed as mean $\pm$ SD. and ranges. *: $p < 0.05$ between groups.

Fig. The sevoflurane concentration and the values of Bispectral Index.

We have no clear explanation for the difference of the results between propofol and sevoflurane, especially concerning to other parameter including spectral edge frequency and amplitude. In our previous study, BIS monitoring during propofol anesthesia was more difficult.

Conclusion: In the current investigation, the most important factor about unreliability of calculated BIS value was a failure of detecting burst suppression pattern of electroencephalogram during deep anesthesia. The modified electrode ameliorate a dependability, however, there was a room for further improvement in this system. The reliability of BIS values for evaluating the depth of shallow anesthesia might be acceptable.