A case in which motor evoked potential could be elicited despite an increase in remifentanil dose during craniotomy.

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Citation

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Abstract

We performed anesthetic management for craniotomy, during which motor evoked potential (MEP) was elicited by direct motor cortex stimulation (DMS), in a female patient with brain aneurysm. Propofol and remifentanil were used for anesthetic induction and maintenance. The propofol concentration was adjusted in accordance with bispectral index value, and the remifentanil concentration was adjusted in accordance with the hemodynamic values. Although we planned to use a remifentanil dose of 0.2 g/kg/min on the basis of a previous report, the dose had to be increased to 0.5g/kg/min, the effect-site concentration was calculated to be 17.2 ng/mL by using a pharmacokinetic simulation, which was in accordance with the hemodynamic values. However, MEP could be well elicited throughout MEP monitoring. This finding was consistent with that of previous studies in which MEP was elicited by transcranial electrical stimulation (TCS) or transcranial magnetic stimulation (TMS). Emergence from anesthesia is well, and no side effects or new neurological deficits occurred. It is thought remifentanil might have also a wide dosage window with respect to monitoring MEP elicited by DMS.

INTRODUCTION

Motor evoked potentials (MEPs) are useful for monitoring neurological function during cranial and spinal procedures1, 2; however, consideration must be given to anesthetic management because anesthetics have a high influence on MEP1. We experienced a case in which MEP could be elicited by direct motor cortex stimulation (DMS) despite an increase in the remifentanil dose to 0.5 g/kg/min.

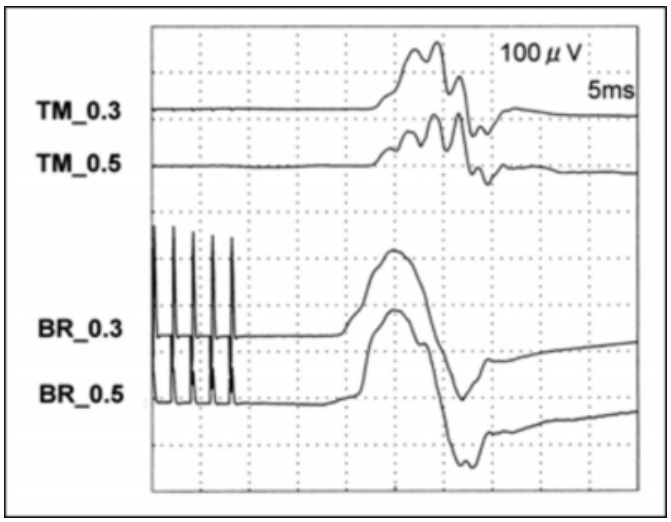
CASE DESCRIPTION

The Research Ethics Committee of Asahikawa Medical College approved and monitored the anesthetic management for craniotomy performed using intravenous anesthetics, and we obtained written informed consent from the patient in whom MEP was performed during craniotomy. The patient was a female in her 50s and had a height of 156 cm and weight of 76 kg. She had been experiencing a feeling of staggering for 4 months and was diagnosed with brain aneurysm, for which a surgery was scheduled. She did not receive any premedication. In addition to standard monitoring, we performed invasive monitoring of blood pressure (BP) and measured the bispectral index (BIS) value by using the BIS® monitor (Aspect, BIS Monitor A-2000; Nihon Kohden, Tokyo, Japan). We administered propofol by using a target-controlled infusion (TCI) system (DiprifusorTM; AstraZeneca Pharmaceuticals, Cheshire, UK) and performed continuous infusion of remifentanil for anesthetic induction and maintenance. We administered vecuronium (0.1 mg/kg) only for tracheal intubation, and no additional muscle relaxant was administered. The target concentrations of propofol were adjusted to maintain the BIS value within 40–60. The remifentanil doses were adjusted according to the hemodynamic parameters, including the heart rate (HR), which was kept within 50–70 beats/min (bpm), and the systolic blood pressure (SBP), which was kept within 80–110 mmHg. Muscular blockade was reversed with 2.5 mg of neostigmine and 1.0 mg of atropine for MEP monitoring; no effect of the muscle relaxant was confirmed by recovery of train-of-four response before commencing MEP monitoring. MEPs were elicited by DMS (train-of-five; stimulation rate, 500 Hz; a pulse with a time constant of 200 s; stimulation intensity, 20 mA) by using an evoked potential/electromyograph (EMG) measuring system (Neuropack® MEB 2200; Nihon Kohden, Tokyo, Japan). Plate electrodes were also inserted into the subdural space. MEPs were recorded using the same system via plate electrodes placed on the target muscle in the extremities (the left thenar muscles and brachioradialis muscle).

The target concentration of propofol and the remifentanil dose were 1.6–2.2 μg/mL and 0.058–0.5 μg/kg/min, respectively, during surgery, and 2.0–2.2 μg/mL and 0.3–0.5μg/kg/min, respectively, during MEP monitoring. Although the remifentanil dose had to be increased to 0.5 μg/kg/min in accordance with the hemodynamic values, MEP could be elicited throughout the duration when MEP was monitored (Fig. 1).

Figure 1

Fig. 1 Motor evoked potential waveform.



Motor evoked potentials (MEPs) were elicited at both the thenar and brachioradialis muscles through microsurgery. No remarkable changes were observed in either of the muscles at remifentanil doses between 0.3 and 0.5 μg/kg/min. TM: thenar muscles; BR: brachioradial muscle; 0.3: remifentanil dose 0.3 μg/kg/min; 0.5: remifentanil dose of 0.5 μg/kg/min.

Because the hemodynamic parameters were stable, no cardiovascular agents had to be administered. Then, extubation could be performed smoothly, immediately after the completion of the surgery because the patient promptly recovered from anesthesia. No side effects were observed, and new neurological deficits did not occur. We calculated the effect-site concentration (ESC) of remifentanil using the STUNPUMP software (available at: http://opentci.org/doku.php; accessed on March 1, 2010) with Minto's parameter3, and we found that the ESC was 10.3–17.2 ng/mL during MEP monitoring.

DISCUSSION

Remifentanil is thought to be a suitable agent for monitoring MEP because of its rapid titration and because it offers a much wider dosage range with respect to the recording of myogenic MEP elicited by transcranial electrical stimulation (TCS) and transcranial magnetic stimulation (TMS)1, 2, 4-7. Further, we have also reported the usefulness of remifentanil by using TCI for monitoring MEP elicited by DMS8. During microsurgery, the patients must be completely immobilized by administering minimal or no relaxant. Remifentanil is an almost ideal agent for this purpose because it is eliminated within a short duration and it offers a wide dosage range for monitoring MEP. The exact concentration of remifentanil required for completely immobilizing the patient and for eliciting MEP by DMS is unknown. However, the experimental study on MEP or the previous studies, in which MEP was elicited either by TCS or TMS, have shown that a comparatively high dose of remifentanil may help achieve both immobilization and MEP monitoring1, 2, 4-7.

We had previously used a remifentanil dose of 0.2 μg/kg/min while monitoring MEP elicited by DMS on the basis of a detailed study in which MEP was elicited by TCS or TMS5, 7. In our previous report, the target ESC of remifentanil was set at 5 ng/mL, when the dosage was approximately 0.17 μg/kg/min8. However, in the present case, the remifentanil dose had to be increased to 0.5 μg/kg/min in accordance with the hemodynamic values; nevertheless, MEP could be well elicited. It is thought that remifentanil dose could increase even during monitoring MEP elicited by DMS in consistent with monitoring MEP elicited by TCS or TMS, in which remifentanil dose increase to 0.4 or 1.0 μg/kg/min4, 6. In the present case, the remifentanil ESC for immobilization is unknown; however, we found that MEP could be elicited by DMS at a remifentanil ESC of 17.2 ng/mL.

We found that even if the remifentanil concentration had to be increased to 0.5 μg/kg/min, MEP could be elicited by DMS. Further research must be conducted to determine the exact concentration of remifentanil required for achieving complete immobilization of the patient and the acceptable dosage for monitoring MEP by DMS.

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