Use of ADMS™ during sedation for dental treatment of an intellectually disabled patient: a case report

Seong In Chi¹, Hyun Jeong Kim¹, Kwang-Suk Seo¹, Martin Yang² and Juhea Chang³

¹Department of Dental Anesthesiology, Seoul National University Dental Hospital, Seoul, Korea.
²Research Institute, Unimedics CO., LTD., Seoul, Korea
³Special Care Clinic, Seoul National University Dental Hospital, Seoul, Korea

Dental treatment is often performed under general anesthesia or sedation when an intellectually disabled patient has a heightened fear of treatment or has difficulty cooperating. When it is impossible to control the patient due to the severity of intellectual disability, conscious sedation is not a viable option, and only deep sedation should be performed. Deep sedation is usually achieved by propofol infusion using the target controlled infusion (TCI) system, with deep sedation being achieved at a slightly lower concentration of propofol in disabled patients. In such cases, anesthesia depth monitoring using EEG, as with a Bispectral Index (BIS) monitor, can enable dental treatment under appropriate sedation depth. In the present case, we performed deep sedation for dental treatment on a 27-year-old female patient with mental retardation and severe dental phobia. During sedation, we used BIS and a newly developed Anesthetic Depth Monitor for Sedation (ADMS™), in addition to electrocardiography, pulse oximetry, blood pressure monitoring, and capnometry for patient safety. Oxygen was administered via nasal prong to prevent hypoxemia during sedation. The BIS and ADMS™ values were maintained at approximately 70, and dental treatment was successfully performed in approximately 30 min.

Keywords: ADMS; Anesthesia depth monitoring; Disabilities; Propofol; Sedation.
Fig. 1. Dental treatment under intravenous propofol sedation with BIS and ADMS sensors attached.

or respiratory distress, including the use of carbon dioxide tension monitoring, while appropriate skills are also required to maintain the airway [5]. One of the drugs commonly used to perform deep sedation is propofol, which is known to require a lower dose in disabled patients than in normal adults [6]. Therefore, performing anesthesia depth monitoring using EEG, as with a Bispectral Index (BIS) monitor, can prevent complications associated with overdose and can be helpful in maintaining proper sedation depth [7]. ADMS™ (Anesthetic Depth Monitor for Sedation, Unimedics CO., LTD., Seoul, Korea) is a newly developed anesthetic depth measurement monitor, which displays the patient’s arousal state as a score of 0-99 points. Scores of 60-80 indicate sedation state.

In the present case, deep sedation for dental treatment was performed for a total of 30 min on a 27-year-old female patient with intellectual disability and severe dental phobia. For sedation depth monitoring, BIS and the ADMS device were used; the effectiveness of ADMS in sedation depth monitoring is reported here, along with a literature review.

CASE

A 27-year-old female patient with intellectual disability visited the Seoul National University Dental Hospital Special Care Clinic. The patient exhibited several missing teeth (#14, #24, #46, and #47) and malocclusion (anterior open bite). Overall gingival condition was healthy in spite of insufficient oral hygiene maintenance. The patient and her parents wanted to improve her masticatory function by dental restoration.

The first visit for dental treatment was performed under general anesthesia. For restoration of a missing tooth (#14), a three-unit porcelain-fused-to-gold fixed prosthesis was planned. Teeth #13 and #15 were prepared and an impression was obtained. At the second visit, deep sedation was performed. The fixed prosthesis was cemented with resin-modified glass ionomer luting cement (FujiCem, GC, Tokyo, Japan).

The patient had a history of Tetralogy of Fallot corrective surgery at the age of 1 year, which required administration of antibiotics during dental treatment for prevention of endocarditis, but there were no other specific findings in the pre-anesthesia examination. Although no cervical extension or abnormal mouth opening was found on the airway examination, the patient did show persistent involuntary movements. On the day prior to sedation being performed, the patient was required to fast for 8 h and a 22-gauge intravenous (IV) line was secured. After an IV injection of 30 mg lidocaine, IV propofol was administered using a target concentration infusion (TCI) device (Fresenius Orchestra, Fresenius Kabi, Germany), with effect-site target concentration set to 3 µg/ml. After the patient became unconscious, a pulse oximeter, an electrocardiograph, and a blood pressure monitor were attached to the patient, while oxygen was supplied at a rate of 5 L/min through a nasal cannula, and end-tidal carbon dioxide tension (EtCO2) and respiratory pattern were monitored using the carbon dioxide suction tube on the nasal cannula (Fig. 1). After a few minutes, the patient reached a state of deep sedation, at which time, respiration stabilized to a satisfactory level, oxygen saturation level was stable, and a state of deep sedation in which the patient would not move in response to stimuli from dental treatment was
Using ADMS™ for sedation

Throughout the treatment, respiratory rate of 10 breaths/min and EtCO2 of 40-50 mmHg were maintained, while the vital signs were maintained at blood pressure 100-90/60-50 mmHg, heart rate 70-80 beats/min, and body temperature 36.5°C. The BIS scores and qCON scores of ADMS were maintained at around 70 (Fig. 2). Although the overall electromyographic (EMG) value was high, acceptable ADMS values were shown. When the patient regained consciousness, ADMS qCON values increased immediately to > 90 (Fig. 3). The total time required in performing sedation was approximately 30 min; after 30 min in the recovery room, the patient was discharged after confirming that her consciousness and movements had returned to normal. A parent was contacted by telephone after discharge, and no specific complications were reported.

**DISCUSSION**

Dental treatment of disabled patients has become increasingly common in Korea because of recent economic growth and increased interest among dentists, with many dental hospitals performing treatment with general anesthesia and sedation. Sedation must be performed by medical personnel capable of maintaining the airway and performing emergency treatment, and the patient and guardian must be provided sufficient explanation of the risks associated with sedation; prior written consent must be obtained. Continued patient monitoring must be performed during sedation, and it is also necessary to have the infrastructure necessary to allow the patient to recover safely until discharge [8].

The BIS monitor simplifies the measurement of the degree of sedation and hypnosis from anesthetics or sedatives and is displayed as a number [9]. The BIS value displays the arousal and unconscious state as a score from 0 to 100 by using a specific algorithm to analyze and process the degree of changes in electrical activities of the cerebral cortex in response to anesthesia. Using BIS monitoring can prevent arousal during anesthesia, as well
Fig. 4. The qCON algorithm is based on the combination of the energy of four frequency ratios, which generates an index, and is then offset by the value of the EEG suppression rate, called BSR (Burst Suppression Ratio). The four frequency ratios are: B1 = \ln (E(4-8 Hz)/E(1-44 Hz)), B2 = \ln (E(8-13 Hz)/E(1-44 Hz)), B3 = \ln (E(11-22 Hz)/E(1-44 Hz)), and B4 = \ln (E(33-44 Hz)/E(1-44 Hz)).
with typical EEGs, abnormal EEG patterns may affect BIS monitoring, but a recent report indicated high correlation between patients with neurological disability and sedative effect [21]. However, there are other reports of BIS values being abnormal in patients with neurological disability, as well as reports of BIS values being low in patients with Alzheimer’s dementia or multi-infract dementia, even when measured in an awake state [22]; pediatric patients with cerebral palsy showed lower BIS values than normal pediatric patients when anesthetized with sevoflurane [23]. Another study reported that pediatric patients with intellectual disability showed lower BIS values than did normal children during anesthesia maintenance and arousal [24]. When measured in a patient in a persistent vegetative state who had undergone general anesthesia for a dental procedure, pre-anesthesia BIS had decreased to 74-85 points due to neurological injury, and the values decreased even further following sevoflurane administration [25].

In conclusion, successful dental treatment under sedation was possible in the present case using IV propofol and ADMS to monitor the state of sedation. Use of ADMS for dental treatment of disabled patients can provide a level of sedation depth monitoring comparable to that of BIS.

Declaration of Conflicts of Interest: The authors have no conflicts of interest to report. But The ADMS™ machine and sensors are supported by Research Institute, Unimedics CO., LTD., Seoul, Korea

Consent: Informed consent was obtained from the patient for this case report and any accompanying images.

REFERENCES

1. Caputo AC. Providing deep sedation and general anesthesia for patients with special needs in the dental office-based setting. Spec Care Dentist 2009; 29: 26-30.
2. Romer M. Consent, restraint, and people with special needs: A review. Spec Care Dentist 2009; 29: 58-66.
3. Gordon SM, Dionne RA, Snyder J. Dental fear and anxiety as a barrier to accessing oral health care among patients with special health care needs. Spec Care Dentist 1998; 18: 88-92.
4. Bing JH, Jeon JY, Jung SH, Hwang KG, Park CJ, Seo KS, et al. Sedation for dental treatment of patients with disabilities. J Korean Dent Soc Anesthesiol 2007; 7: 114-9.
5. Malamed SF, Gottschalk HW, Mulligan R, Quinn CL. Intravenous sedation for conservative dentistry for disabled patients. Anesth Prog 1989; 36: 140-2.
6. Lee BS, Shin TJ, Kim HJ, Choi YJ, Lee SE, Chang J, et al. Effect site concentrations of propofol for dental treatment under deep sedation in intellectually disabled patients. J Korean Dent Soc Anesthesiol 2014; 14: 167-72.
7. Donaldson M, Goodchild JH. Use of bispectral index system (bis) to monitor enteral conscious (moderate) sedation during general dental procedures. J Can Dent Assoc 2009; 75: 709.
8. Malviya S, Voeapel-Lewis T, Prochaska G, Tait AR. Prolonged recovery and delayed side effects of sedation for diagnostic imaging studies in children. Pediatrics 2000; 105: 185-9.
9. Liu J, Singh H, White PF. Electroencephalographic bispectral index correlates with intraoperative recall and depth of propofol-induced sedation. Anesth Analg 1997; 84: 185-9.
10. Punjasawadwong Y, Phongchiewboon A, Bunchungmongkol N. Bispectral index for improving anaesthetic delivery and postoperative recovery. The Cochrane Library 2007; CD003843.
11. Klopman MA, Sebel PS. Cost-effectiveness of bispectral index monitoring. Curr Opin Anaesthesiol 2011; 24: 177-81.
12. Messieha ZS, Ananda RC, Hoffman WE, Purnwani IC, Koenig HM. Bispectral index system (bis) monitoring reduces time to discharge in children requiring intramuscular sedation and general anesthesia for outpatient dental rehabilitation. Pediatr Dent 2004; 26: 256-60.
13. Haenggi M, Ypparila-Wolters H, Hauser K, Caviezel C, Takala J, Korhonen I, et al. Intra- and inter-individual
variation of bis-index and entropy during controlled sedation with midazolam/remifentanil and dexmedetomidine/remifentanil in healthy volunteers: An interventional study. Crit Care 2009; 13: 1.
14. Shah P, Manley G, Craig D. Bispectral index (bis) monitoring of intravenous sedation for dental treatment. SAAD Dig 2014; 30: 7-11.
15. Yang Z, Wang Y, Ouyang G. Adaptive neuro-fuzzy inference system for classification of background eeg signals from eses patients and controls. Scientific World Journal 2014; 2014: Article ID 140863.
16. Rampil IJ, Kim JS, Lenhardt R, Negishi C, Sessler DI. Bispectral eeg index during nitrous oxide administration. Anesthesiaology 1998; 89: 671-7.
17. Dahaba AA. Different conditions that could result in the bispectral index indicating an incorrect hypnotic state. Anesth Analg 2005; 101: 765-73.
18. Pfle G, Zanner R, Schneider G, Blum J, Kreuzer M, Kochs EF. Time delay of index calculation: Analysis of cerebral state, bispectral, and narcotrend indices. Anesthesiology 2006; 104: 488-94.
19. Vivien B, Di Maria S, Ouattara A, Langeron O, Coriat P, Riou B. Overestimation of bispectral index in sedated intensive care unit patients revealed by administration of muscle relaxant. Anesthesiology 2003; 99: 9-17.
20. Baldesi O, Bruder N, Velly L, Gouin F. Spurious bispectral index values due to electromyographic activity. Eur J Anaesthesiol 2004; 21: 324-5.
21. Deogaonkar A, Gupta R, DeGeorgia M, Sabharwal V, Gopakumaran B, Schubert A, et al. Bispectral index monitoring correlates with sedation scales in brain-injured patients. Crit Care Med 2004; 32: 2403-6.
22. Renna M, Handy J, Shah A. Low baseline bispectral index of the electroencephalogram in patients with dementia. Anesth Analg 2003; 96: 1380-5.
23. Choudhry DK, Brenn BR. Bispectral index monitoring: A comparison between normal children and children with quadriplegic cerebral palsy. Anesth Analg 2002; 95: 1582-5.
24. Valkenburg AJ, de Leeuw TG, Tibboel D, Weber F. Lower bispectral index values in children who are intellectually disabled. Anesth Analg 2009; 109: 1428-33.
25. Pandit JJ, Schmelze-Lubiecki B, Goodwin M, Saeed N. Bispectral index-guided management of anaesthesia in permanent vegetative state. Anaesthesia 2002; 57: 1190-4.