Intravenous Sedation for Implant Surgery: Midazolam, Butorphanol, and Dexmedetomidine Versus Midazolam, Butorphanol, and Propofol

Hiroyoshi Kawaai, DDS, PhD[1]*
Shu Tomita, DDS[1]
Yoshihiro Nakaike, DDS[1]
Steven Ganzberg, DMD, MS[2]
Shinya Yamazaki, DDS, PhD[1]

We compared the amnesic action, recovery process, and satisfaction of patients and surgeons after the use of 2 different sedation regimens for 40 patients undergoing scheduled implant surgery. Butorphanol, midazolam, dexmedetomidine (BMD) was administered to 20 patients who were maintained with continuous infusion of dexmedetomidine after the induction with butorphanol and midazolam, and butorphanol, midazolam, propofol (BMP) was administered to 20 patients who were maintained with continuous infusion of propofol after the induction with butorphanol and midazolam. To assess the amnesic action, the memory of local anesthesia, auditory memory, and visual memory were evaluated. The Trieger Dot Test (TDT) was applied during the recovery process. A questionnaire regarding the patient's feelings of the management of sedation was taken from each patient and was also filled out by the surgeon. The comparison between groups was analyzed by the Mann-Whitney *U* test. No significant differences in the amnesic action and the TDT were noted. Both methods also satisfied the patients and surgeons, as determined by the questionnaire results. In conclusion, both sedation regimens are appropriate for implant surgery.

Key Words: dexmedetomidine, propofol, midazolam, butorphanol, intravenous sedation, amnesic action

INTRODUCTION

Propofol (PRO) is an intravenous anesthetic that produces anesthesia of short duration[1] and excels in the adjustment of the depth of anesthesia. It also allows for rapid recovery following repeated administration and makes patients awaken quickly postsedation. In dentistry, PRO is frequently used during sedation for implant surgery.[2,3] However, in a study examining the amnesic action of PRO using an injection needle as a painful stimulation, it was reported that amnesia occurred in 50% of the subjects.[4]

On the other hand, dexmedetomidine (DEX) is a sedative and analgesic agent that acts via the α-2 adrenoceptor,[5] which is associated with reduction of anesthetic requirements.[6] DEX shows a sedative effect similar to natural sleep,[7] and patients can easily be wakened even if sedated with DEX. It has been reported that it took 10 minutes to reach an optimal sedative level when intravenous sedation was performed with only DEX.[7] In addition, it took at least 2 hours to recover fully from sedation with DEX,[8] considering the elimination half-life of DEX in blood is 2–3 hours.[9]

In an ideal intravenous sedation in dentistry, an effective amnesic action, easy regulation, and rapid recovery are required. In the present study, we

[1] Department of Dental Anesthesiology, Ohu University School of Dentistry, Fukushima, Japan.
[2] Department of Anesthesiology, Ohio State University College of Dentistry, Columbus, Ohio.
* *Corresponding author,* e-mail address: maromaro@ce.mbn.or.jp
DOI: 10.1563/AAID-JOI-D-11-00200

Downloaded from http://meridian.allenpress.com/joi/article-pdf/40/1/94/2039851/aaid-joi-d-11-00200.pdf by guest on 18 October 2021

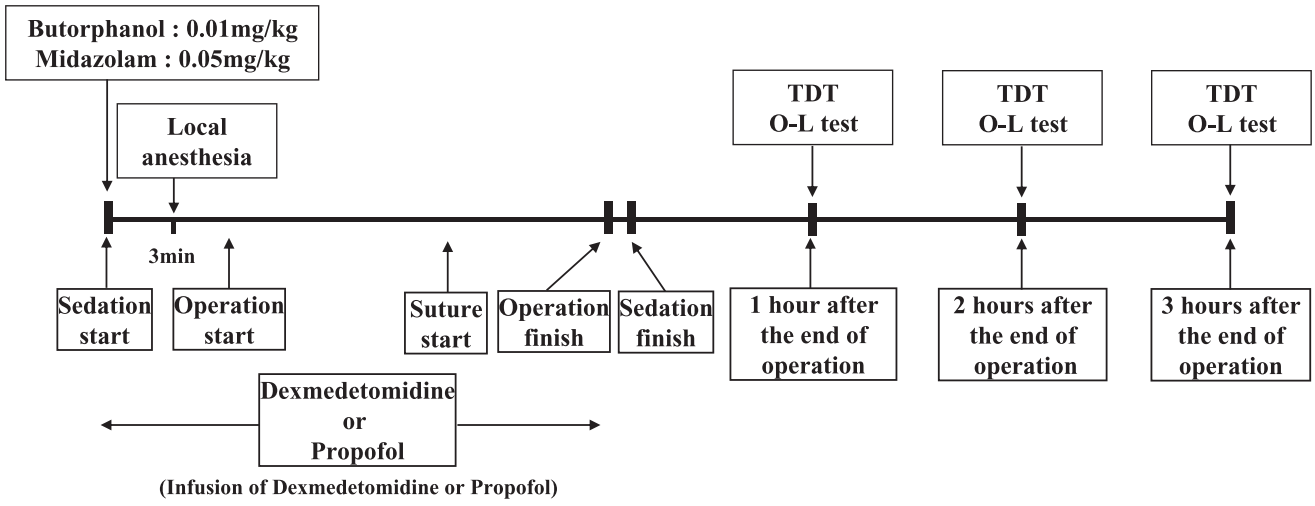


Figure 1. The time course of the investigation. The subjects' blood pressure, heart rate, electrocardiogram, and SpO_2 (percentage percutaneous oxygen saturation) were monitored by a hemodynamometer. After vital signs were checked, they were sedated with a continuous infusion of dexmedetomidine or propofol after the induction with 0.01 mg/kg butorphanol and 0.05 mg/kg midazolam, and their sedation level was kept at −2 to −3 on the Richmond Agitation Score. Local anesthesia was injected at 3 minutes after the start of sedation, and 100% oxygen (3 L/min) was given via nasal cannula until 1 hour after the end of the operation. Memory of local anesthesia, auditory memory (calling for the start of sutures), and visual memory (watches, syringes, and so on shown at the end of each operation) to assess the amnesic action were evaluated. To determine the psychomotor function and recovery of equilibrium during the recovery process, the Trieger Dot Test (TDT p.e.r.) and 1-leg standing test with closed eyes (O-L test) were applied until 3 hours after the end of the operation.

investigated the amnesic action and recovery process and surveyed the sedation comfort for implant surgery by questionnaire in patients who were maintained with either DEX or PRO after sedation induced by 0.01 mg/kg butorphanol (BUT) and 0.05 mg/kg midazolam (MID).

Subjects and Methods

Subjects

The subjects included in this study were 40 patients who were scheduled for implant surgery (2–4 abutments) at our hospital. They were divided into 2 groups by random sampling methods. BMD (BUT, MID, DEX) was administered to 20 subjects who were maintained with continuous infusion of DEX after 0.01 mg/kg BUT and 0.05 mg/kg MID were given intravenously, and BMP (BUT, MID, PRO) was administered to the other group of 20 subjects who were maintained with continuous infusion of PRO after 0.01 mg/kg BUT and 0.05 mg/kg MID were given intravenously. This study was approved by the ethical committee, and informed consent was obtained from each patient prior to the procedure.

Methods

As shown in Figure 1, before entering the operating room, the Trieger Dot Test plot error ratio[10] (TDT p.e.r.) and a one-leg standing test with closed eyes for 15 seconds[8] (O-L test) were examined in all patients. When a patient was unable to successfully perform the O-L test for 15 seconds, the average time from 3 trials of the O-L test was adopted as the control value.

After entering the operating room, the subjects were kept in a supine position, an intravenous catheter (InsyteTM 22-gauge, Becton Dickinson, Franklin Lakes, NJ) was inserted into a medial cubital vein, and an infusion of lactated Ringer's solution was started at 2 mL/kg/h. The subjects' blood pressure, heart rate, electrocardiogram, and SpO_2 (percutaneous oxygen saturation) were monitored by a hemodynamometer. After it was confirmed that there were no problems indicated by the patient's vital signs, 0.01 mg/kg BUT and 0.05 mg/kg MID were given intravenously. At the same time, the continuous infusion of DEX or PRO was started, and their sedation level was kept at −2 to −3 on the Richmond Agitation Score (RAS).[11]

For the BMD group, 20 subjects were maintained

Downloaded from http://meridian.allenpress.com/joi/article-pdf/40/1/94/2039851/aaid-joi-d-11-00200.pdf by guest on 18 October 2021

TABLE 1

Questionnaire presented to subjects*

1. Did you feel discomfort during sedation?

a. Yes b. No

If you replied 'a. Yes', what made you feel discomfort?

( )

2. Did you feel discomfort after sedation?

a. Yes b. No

If you replied 'a. Yes', what made you feel discomfort?

( )

3. Would you like to be managed with the same sedative method if you were sedated again?

a. Yes b. No

4. Others

*This is a questionnaire regarding a subject's feelings during and after the operation.

TABLE 2

Questionnaire presented to surgeons*

1. Could you easily operate for implant surgery during sedation?

a. Yes b. No

If you replied 'a. Yes', please tell us the reason.

a. Subjects did not have a pain during sedation.

b. Subjects did not choke during sedation.

c. Subjects followed surgeon's instruction during sedation.

d. Others

If you replied 'b. No', please tell us the reason.

a. Subjects had a pain during sedation.

b. Subjects choked during sedation.

c. Subjects followed surgeon's instruction during sedation.

d. Others

2. Do you want a dental anesthesiologist to perform the same sedation if you operate for implant surgery again?

a. Yes b. No

3. Others

*This is a questionnaire regarding the management of sedation that each surgeon filled out postoperatively.

with continuous infusion of DEX after 0.01 mg/kg BUT and 0.05 mg/kg MID were given intravenously. For the BMP group, 20 subjects were maintained with continuous infusion of PRO after 0.01 mg/kg BUT and 0.05 mg/kg MID were given intravenously.

The maintenance of sedation with DEX or PRO was selected by a double-blind method, and the infusion of DEX or PRO was continued until the end of the operation. In all cases, local anesthesia was injected by one dental anesthesiologist at 3 minutes after the sedation started, and another dental anesthesiologist adjusted the sedative level during the operations. Oxygen (100%; 3 L/min) was given via a nasal cannula during sedation, and it was discontinued at 1 hour after the end of the operation. Memory of local anesthesia, auditory memory (call "We suture now!" for the start of sutures), and visual memory (watches or syringes, etc, shown at the end of each operation) to assess the amnesic action were verified at 3 hours after the end of each operation. To determine psychomotor function and the recovery of equilibrium during the recovery process, the TDT p.e.r. and O-L test were applied. Before leaving the hospital, a questionnaire regarding the patient's feelings during and after the operation was administered to each subject (Table 1), and a questionnaire regarding the management of sedation (Table 2) was completed by each surgeon.

Statistical analyses

The Mann-Whitney *U* test and chi-square test were applied for statistical analysis between groups. In the TDT p.e.r., Friedman's test was applied for statistical analysis for each group. Values of $P < .05$ were considered to be statistically significant.

RESULTS

Table 3 presents patient age, gender, body weight, duration of intravenous sedation, operative duration, number of implant abutment, quantity of local anesthesia, time from sedation onset to operation onset, time from operation onset to suture onset, frequency of choking over during operation, average dose of continuous infusion of DEX, and average dose of continuous infusion of PRO.

The average age was 53.5 $\pm$ 9.9 years in the BMD group and 54.1 $\pm$ 9.0 years in the BMP group. The gender distribution was 8:12 (male:female) in the BMD group and 6:14 (male:female) in the BMP

Downloaded from http://meridian.allenpress.com/joi/article-pdf/40/1/94/2039851/aaid-joi-d-11-00200.pdf by guest on 18 October 2021

TABLE 3

Details of the subjects and the implant surgeries performed in the present study*

	BMD	BMP
Age (y)	53.5 ± 9.9	54.1 ± 9.0
Male:Female	8:12	6:14
Weight (kg)	55.1 ± 9.7	58.5 ± 10.2
Sedative duration (min)	78.1 ± 14.5	76.2 ± 16.1
Operative duration (in)	56.9 ± 13.8	56.2 ± 15.7
Implant number	2.0 ± 0.6	2.1 ± 0.8
Quantity of local anesthesia (mL)	5.6 ± 1.1	5.2 ± 0.9
Sedation start → operation start (min)	16.1 ± 4.1	15.8 ± 3.2
Operation start → suture start (min)	45.5 ± 13.7	43.0 ± 13.8
Frequency of choking during operation	0.8 ± 1.4	1.3 ± 2.4
Average dose of continuous infusion of DEX (μg/kg/h)	0.56 ± 0.14	
Average dose of continuous infusion of PRO (mg/kg/h)		2.3 ± 0.0

*The details of the subjects and the implant surgeries performed in the present study are shown. There were no significant differences between both groups. BMD indicates butorphanol, midazolam, dexmedetomidine; BMP, butorphanol, midazolam, propofol; DEX, dexmedetomidine; PRO, propofol.

group. The body weight was 55.1 ± 9.7 kg in the BMD group and 58.5 ± 10.2 kg in the BMP group. The duration of intravenous sedation was 78.1 ± 14.5 minutes and 76.2 ± 16.1 minutes in the BMD and BMP groups, respectively. The duration of the operation was 56.9 ± 13.8 minutes in the BMD group and 56.2 ± 15.7 minutes in the BMP group. The average number of implant abutments was 2.0 ± 0.6 and 2.1 ± 0.8, respectively, for the BMD and BMP groups. The quantity of local anesthesia was 5.6 ± 1.1 mL in the BMD group and 5.2 ± 0.9 mL in the BMP group. The time from sedation onset to operation onset was 16.1 ± 4.1 minutes and 15.8 ± 3.2 minutes, while the time from operation onset to suture onset was 45.5 ± 13.7 minutes and 43.0 ± 13.8, respectively, in the BMD and BMP groups. The frequency of choking over during the operation was 0.8 ± 1.4 in the BMD group and 1.3 ± 2.4 in the BMP group. There were no significant differences in any of the items between the BMD and BMP groups. The average dose of continuous infusion of DEX was 0.56 ± 0.14 μg/kg/h in the BMD group, and the average dose of continuous infusion of PRO was 2.3 ± 0.0 mg/kg/h in the BMP group.

Amnesic action

The amnesic action to local anesthesia was 90% in the BMD group and 95% in the BMP group. At the suture onset, the amnesic action to the auditory memory of call "We suture now!" was 80% in the BMD group and 95% in the BMP group. At the end of each operation, the amnesic action of visual memory after patients were shown watches, syringes, and so on was 80% and 90% in the BMD and BMP groups, respectively. There was no significant difference in each item between the 2 groups (Figure 2).

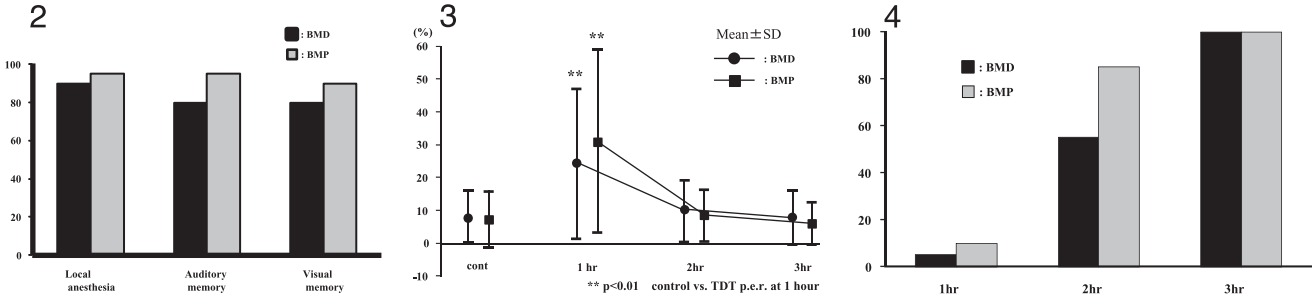
TDT p.e.r.

The TDT p.e.r. at 1 hour after the end of the operation was 24.1% ± 23.0% in the BMD group and 30.1% ± 27.8% in the BMP group. At 2 hours after the end of the operation, it was 9.8% ± 9.5% and 7.8% ± 7.9% in the BMD and the BMP groups, respectively. At 3 hours after the end of the operation, it was 7.7% ± 8.2% in the BMD group and 5.5% ± 6.5% in the BMP group. When comparing the BMD and the BMP groups, there were no significant differences at 1 hour, 2 hours, or 3 hours after the end of the operation (Figure 3). However, in both groups, the TDT p.e.r. at 1 hour after the end of the operation was significantly increased in comparison with each baseline value.

O-L test

A total of 5% of subjects (1 patient) and 10% of subjects (2 patients), respectively, in the BMD and BMP groups were successful in the O-L test at 1 hour after the end of the operation. However, 55% of subjects (11 patients) in the BMD and 85% of subjects (17 patients) in the BMP group successfully completed the O-L test at 2 hours after the end of the operation. All subjects in both groups could complete the O-L test at 3 hours postinfusion. At 1,

Downloaded from http://meridian.allenpress.com/joi/article-pdf/40/1/94/2039851/aaid-joi-d-11-00200.pdf by guest on 18 October 2021



Figures 2–4. Figure 2. Amnesic action at each point of implant surgery. In the comparison between the butorphanol, midazolam, dexmedetomidine (BMD) and butorphanol, midazolam, propofol (BMP) groups, there were no significant differences in the amnesic action to local anesthesia or in the auditory memory of calling for sutures at the suture onset and visual memory showing watches, syringes, and so forth at the end of each operation. **Figure 3.** The changes in the Trieger Dot Test plot error ratio (TDT p.e.r.). In the comparison between the BMD and BMP groups, there were no significant differences at 1 hour, 2 hours, or 3 hours after the end of the operation. However, in the BMD and BMP groups, the TDT p.e.r. at 1 hour after the end of the operation was significantly increased in comparison with each baseline value ($P < .01$). **Figure 4.** The success rate of the 1-leg standing test with closed eyes (O-L test) at 1, 2, and 3 hours after the end of the operation. A total of 5% of subjects in the BMD group and 10% of subjects in the BMP group were successful in the O-L test at 1 hour after the end of the operation. In contrast, 55% and 85% of subjects in the BMD and BMP groups successfully completed the O-L test at 2 hours after the end of the operation. All subjects in both groups could complete the O-L test at 3 hours postinfusion. At 1, 2, and 3 hours postinfusion, there were no significant differences between the 2 groups.

2, and 3 hours postinfusion, there were no significant differences between the 2 groups (Figure 4).

Questionnaire investigation of subjects

Discomfort during the operation occurred in 10% of subjects (2 patients) in the BMD group and in 15% of subjects (3 patients) in the BMP group. Discomfort during the postoperative period occurred in 15% (3 patients) and in 10% (2 patients) of subjects in the BMD and BMP groups, respectively. In the assessment of discomfort during and after the operation, there were no significant differences between the 2 groups. For the question, "Do you want to be sedated with the same method if you have an opportunity to be sedated again?" all subjects in the BMP group answered yes; however, 5% of subjects (1 patient) in the BMD group did not want to be sedated again using the same method (Figure 5).

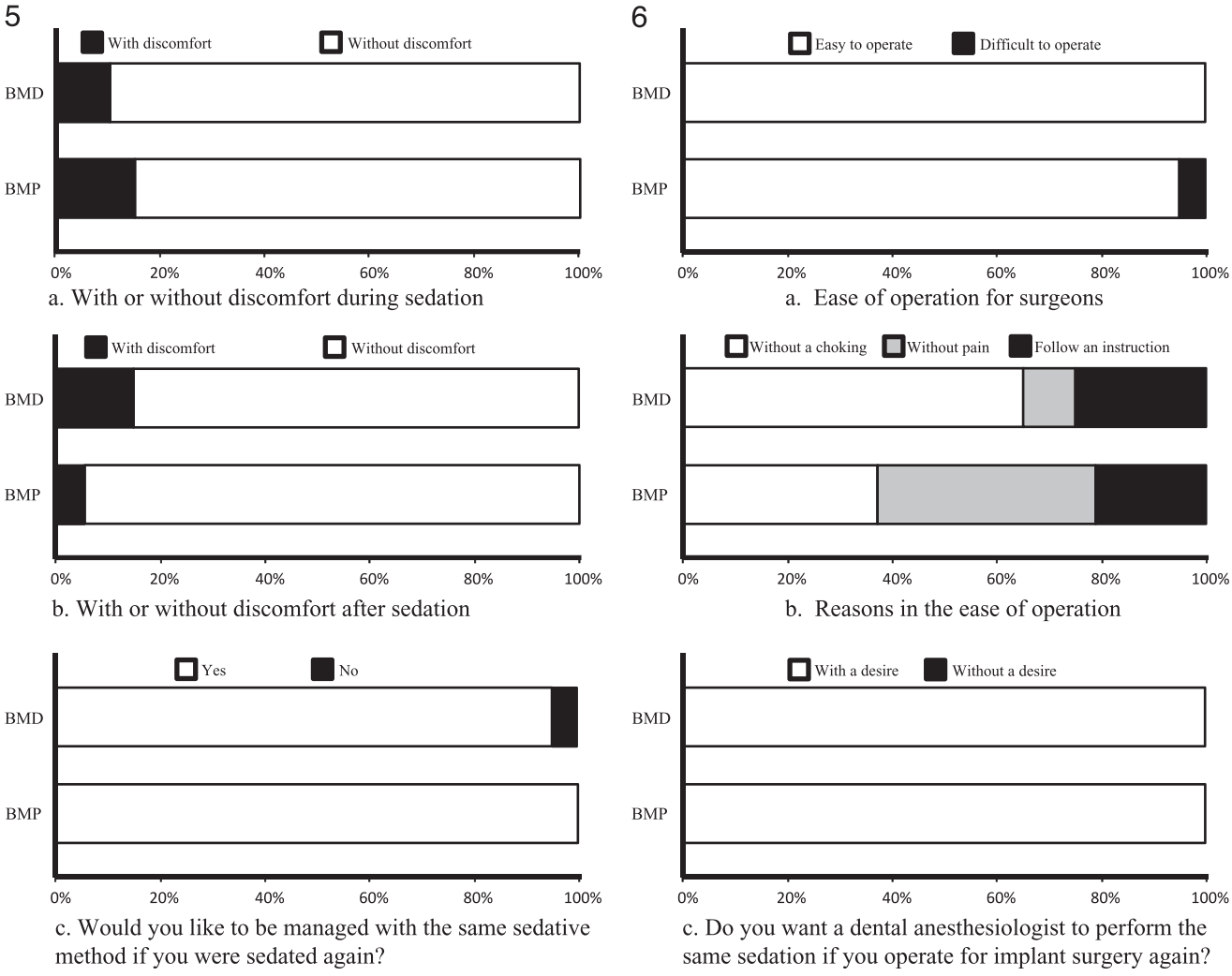
Questionnaire investigation of surgeons

With regard to the ease of operation, all surgeons replied that they could easily operate for implant surgeries for patients in the BMD group. However, the surgeon for 1 patient in the BMP group replied that it was difficult to operate for the implant surgeries. When all surgeons were asked about their reasons for replying "yes" to this question about subjects sedated using BMD method, 65% of them replied that subjects did not choke during the operations. When the surgeons who replied "yes" to the above question about patients sedated using the BMP method were asked why they responded in the affirmative, 42% of them replied that the subjects did not complain of pain during the operations. When the 1 surgeon (5% surgeon) who answered "no" to question 1 in the BMP group was asked why he responded that way, he replied that one of the subjects frequently choked during the operation (Figure 6).

Discussion

Intravenous sedation is one of the management strategies employed for implant surgery in patients with dental phobia. In addition, taking an intravenous line for an intravenous sedation is useful as a first step to avoid the incident during operations and dental procedures, and it has the advantage of allowing for rapid administration of treatment in emergency situations. On the other hand, an ideal intravenous sedation for dentistry should have an effective amnesic action, have easy regulation, and permit rapid recovery. With regard to these points, we investigated the sedative management that added DEX or PRO to an intravenous sedation method based on the infusion of MID and BUT.

Downloaded from http://meridian.allenpress.com/joi/article-pdf/40/1/94/2039851/aaid-joi-d-11-00200.pdf by guest on 18 October 2021



Figures 5–6. Figure 5. The questionnaire presented to subjects. The sensation of discomfort during the operation occurred in 10% of subjects in the butorphanol, midazolam, dexmedetomidine (BMD) group and in 15% of subjects in the butorphanol, midazolam, propofol (BMP) group. Postoperative discomfort was reported by 15% and 10% of subjects in the BMD and BMP group, respectively. In the assessment of discomfort during and after the operation, there were no significant differences between the 2 groups. For the question, "Do you want to be sedated with the same method if you have an opportunity to be sedated again?" all subjects in the BMP group answered yes, while 5% of subjects in the BMD group did not want to be sedated again using the same method. **Figure 6**. The questionnaire presented to surgeons. All surgeons for the BMD group replied that they could easily operate for the implant surgeries. However, 5% of surgeons for the BMP group replied that it was difficult to operate for implant surgery. When all surgeons for the BMD group were asked about their reasons for replying "yes" to the question, 65% replied that subjects did not choke during operations. Of the 95% of surgeons for the BMP group who replied "yes" to the question, 42% indicated that the reason why they answered "yes" was that the subjects did not complain of pain during the operations. Of the 5% of surgeons for the BMP group who responded "no" to the question, it was noted that the reason was that 1 of subjects frequently choked during the operation.

Amnesic action

The amnesic action of local anesthesia (2% lidocaine with 1:80 000 adorenarine) was 90% in the BMD group and 95% in the BMP group. This amnesic action is speculated to be supported by the pharmacologic effects of both BUT and MID. It has been reported that an optimal sedative level could be observed after the administration of the loading dose when DEX was administered as a continuous infusion with 6 μg/kg/h administered as a loading dose.[12] This report suggests that the serum concentration of DEX could not reach a high enough concentration to show an optimal sedative level at 3 minutes after the start of sedation, even if 0.7 μg/kg/h of DEX without a loading dose was infused continuously after the administration of BUT

Downloaded from http://meridian.allenpress.com/joi/article-pdf/40/1/94/2039851/aaid-joi-d-11-00200.pdf by guest on 18 October 2021

and MID. Concerning previous studies of intravenous sedation with PRO, Kawaai et al[4] reported that a subject's sedation level reached an optimal sedative level at 9 minutes after the start of PRO infusion when 6 mg/kg/h of PRO was infused continuously. In the present study, the average continuous dose of PRO was 2.3 ± 0.0 mg/kg/h, which was lower than the continuous infusion dose in Kawaai's study. It was therefore impossible for a subject's sedative level to reach the optimal sedative level at 3 minutes after the start of a continuous infusion of PRO in the present study. Therefore, neither DEX nor PRO contributed to the amnesic action of local anesthesia. Kondo et al[13] reported that the amnesia of visual memory after showing watches, syringes, and so on was recognized soon after 0.05 mg/kg MID was given intravenously, resulting in amnesia in 100% of healthy subjects who participated in the study. The evaluation of the amnesic action of visual memory in that study was not invasive. In the present study, insertion of a needle and an injection of local anesthetic were performed as an evaluation of amnesia. Therefore, this evaluation was invasive, and it was predicted that infusion of only 0.5 mg/kg MID could not obtain amnesia in all patients. To increase the threshold of pain, we administered 0.01 mg/kg BUT combined with MID in the present study. With regard to an intravenous BUT dose, another study[14] reported that 0.5 mg of intravenous BUT (0.0056–0.012 mg/kg) produced adequate analgesia with approximately a 2-hour duration of action for relief of postoperative pain. In the present study, the dose of BUT was 0.01 mg/kg, based on another study.[14] As a result, the amnesic action to local anesthesia was 90% in the BMD group and 95% in the BMP group despite the invasive nature of the procedure, which means that doses of BUT and MID were appropriate in the present study.

The amnesic action for auditory memory (surgeon's call for the start of sutures) was 80% in the BMD group and 95% in the BMP group, and the amnesic action for visual memory (showing watches, syringes, etc, at the end of each operation) at the end of the operation was 80% in the BMD group and 90% in the BMP group. There were no significant differences between the 2 groups. The elimination half-time of MID is 1.5–3 hours[15,16]; in addition, Kaneko et al[17] reported that the sedative effect decreases rapidly between 45 minutes and 60 minutes after the intravenous administration of 0.07 mg/kg MID, and it is diluted from 60 minutes after the administration of 0.07 mg/kg MID. The dosage (0.05 mg/kg) of MID used in the present study was less than that (0.07 mg/kg) in Kaneko's study. The time from sedation onset to suture onset was 62 minutes in the BMD group and 59 minutes in the BMP group, and the time from sedation onset to the end of the operation was 73 minutes in the BMD group and 72 minutes in the BMP group. Considering the amnesic action of MID in the study by Kaneko et al,[17] the sedative effect was speculated to have been decreased at these points in our study. The amnesic actions at these points therefore depended on DEX or PRO. With regard to the sedative effect of DEX, it has been reported that the cognitive function or memory of subjects could be maintained when the continuous infusion dose of DEX was less than 0.7 μg/kg/h.[18] Subjects in the present study were maintained with 0.56 ± 0.14 μg/kg/h (the average continuous infusion dose of DEX in the BMD group), so it is likely that the patients retained their capacity for memory during the operation. Nevertheless, we obtained an excellent amnesic action for both the suture-onset time and the end of operation, which we attributed to the additive effects due to MID and DEX. On the other hand, concerning the amnesic action in intravenous sedation with PRO, other studies have reported that the amnesic action was 63% for an evaluation showing a ballpoint pen under the optimal sedative level[19] and was 80% in the picture recall test.[20] In invasive tests, the amnesic action was 50% or 90%, respectively, in an evaluation using needle pain[4] or electrical dental pulp stimulation[20] under the optimal sedative level. Our data cannot be compared simply with these results in other studies given the different regimens used; however, an excellent amnesic action resulting in at least 80% efficacy was obtained at the suture onset and the end of the operation in the BMP group in this study. This suggests that an excellent amnesic action was obtained, likely due to a synergistic effect between MID and PRO at the point of suture onset and the end of the operation.

Recovery process

Our results indicated that the TDT p.e.r. increased significantly at 1 hour after the end of the operation in both groups. This suggested that the subject's

Downloaded from http://meridian.allenpress.com/joi/article-pdf/40/1/94/2039851/aaid-joi-d-11-00200.pdf by guest on 18 October 2021

orientation was clear beginning 2 hours after the end of the operation. In the present study, DEX or PRO was continuously administered to keep RAS-3 until the end of the operation. However, our findings indicate that DEX or PRO can be discontinued before the end of the operation to shorten the recovery process.

All subjects were successful in the O-L test at 3 hours after the end of the operation. This indicated that we can give patients permission to be discharged from the hospital 3 hours postoperatively. The elimination half-time of MID, BUT, DEX, and PRO are 1.8–3 hours,[15,16] 3–4 hours,[21] 2–3 hours,[9] and 0.8 hours (1/2β),[22] respectively. The point 3 hours after the end of the operation was actually approximately 4 hours after the last administration of MID and BUT and 3 hours after DEX was last infused. This point was speculated to be when the effect of all drugs disappeared. All subjects therefore received permission to go home at 3 hours after the end of the operation, and there were no problems postoperatively in any of the patients.

Questionnaire investigation of subjects

A total of 10% of subjects (2 subjects) in the BMD group experienced discomfort during the operation; 1 subject had a headache, and the other subject felt discomfort due to fluid retention in part of the pharynx. In the BMD group, 15% of subjects (3 subjects) experienced discomfort postoperatively. One was the same subject who had the headache during the operation and also had a headache postoperatively. Two of the subjects reported that they had nausea postoperatively. Their nausea disappeared when they left our hospital. The worst problem in the BMD group was that the 1 subject with the headache during operation kept the headache postoperatively. During her operative course, her headache was minimal 3 hours after the operation, and she did not have the headache after she arrived at home. In the postoperative course of 2 subjects with nausea, their nausea had disappeared by 3 hours after the end of the operation. They were all discharged without nausea. The BUT, MID, and DEX used in the present study have potential side effects of headache and nausea; therefore, it is not possible to determine which drugs were responsible for the headache and nausea in our hospital. Given the elimination half-life of each drug, all of the drugs had the potential to cause these effects.

A total of 15% of the subjects (3 subjects) in the BMP group experienced discomfort during the operation. One of them complained of lip pain caused by a wound retractor. Two other subjects reported that they felt fluid retention in the pharynx. These discomforts could have been improved if surgeons would have taken precautions to ensure careful movement of the wound retractor and to aspirate fluid from the pharynx frequently. It is important for surgeons to pay attention to whether an area may be paralyzed by local anesthesia and to vacuum fluid diligently when it accumulates. Only 5% of subjects (1 subject) in the BMP group complained of heaviness of the head like a headache postoperatively. Both BUT and MID can cause headaches, but PRO generally does not.[23] However, as in the BMD group, it was impossible to identify clearly the offending drug in this patient.

There were no significant differences between the 2 groups in the response to the question, "Would you like to be managed with the same sedative method if you were sedated again?" All of the subjects in the BMP group and 19 subjects in the BMD group responded that they would prefer to undergo the same sedative method. One subject in the BMD group replied "no" to this question and cited postoperative nausea as a reason. In the future, special attention should be paid to the possibility of causing a headache or other side effects when sedation is performed with BMD, and an effective coping strategy should be provided.

Questionnaire investigation of surgeons

A total of 5% of surgeons (1 surgeon) in the BMP group replied "no" to the question, "Could you easily operate for implant surgery during sedation?" and cited the reason that 1 of the patients choked frequently during the operation. This indicates that intravenous sedation with BMP likely blunted the pharyngeal response, leading to fluid retention with drilling. This also suggested that PRO might inhibit the pharyngeal response. On the other hand, 65% of surgeons in the BMD group replied that "it was easy to operate" and stated that subjects did not choke during the operation. In the BMP group, the surgeons replied that "it was easy to operate" and gave the reason that subjects had no pain during the operation. This suggests that sedation with PRO

Downloaded from http://meridian.allenpress.com/joi/article-pdf/40/1/94/2039851/aaid-joi-d-11-00200.pdf by guest on 18 October 2021

might be associated that with an increased frequency of choking compared with DEX, despite the fact that no significant differences were noted between the groups with regard to the frequency of choking.

In conclusion, both BMD and BMP are appropriate for implant surgery in terms of their amnesic action and patient recovery process. Both methods produce a smooth operation and satisfy both oral surgeons and patients. In addition, both DEX and PRO are available as continuous infusion drugs for intravenous sedation.

Abbreviations

BMD: butorphanol, midazolam, dexmedetomidine
BMP: butorphanol, midazolam, propofol
BUT: butorphanol
DEX: dexmedetomidine
MID: midazolam
O-L test: 1-leg standing test with closed eyes
PRO: propofol
SpO_2: percutaneous oxygen saturation
TDT: Trieger Dot Test

References

1. Glen JB. Animal studies of the anaesthetic activity of ICI 35 868. *Br J Anaesth*. 1980;52:731–742.
2. Craig DC, Boyle CA, Fleming GJ, Palmer P. A sedation technique for implant and periodontal surgery. *J Clin Periodontol*. 2000;27:955–959.
3. Niwa H, Tanimoto A, Sugimura M, Morimoto Y, Manamoto H. Cardiovascular effects of epinephrine under sedation with nitrous oxide, propofol, or midazolam. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2006;102:e1–e9.
4. Kawaai H, Tanaka K, Yamazaki S, Sugita T, Okuaki A. A study of intravenous sedation with propofol for dental treatment and oral surgery: influences on respiration, circulation, sedation and recovery process. *J Jpn Dent Soc Anesthesiol*. 1998;26:209–218.
5. Venn RM, Grounds RM. Comparison between dexmetetomidine and propofol for sedation in the intensive care unit: patient and clinician perceptions. *Br J Anaesth*. 2001;87:684–690.
6. Aho M, Lehitinen A-M, Erkola O, Kallio A, Kortilla K. The effect of intravenously administered dexmedetomidine on perioperative hemodynamics and isoflurane requirements in patients undergoing abdominal hysterectomy. *Anesthesiology*. 1991;74:997–1002.
7. Ogawa S, Seino H, Ito H, Yamazaki S, Ganzberg S, Kawaai H. Intravenous sedation with low-doses dexmedetomidine: its potential for use in dentistry. *Anesth Prog*. 2008;55:82–88.
8. Kawaai H, Satoh J, Watanabe M, Kan K, Ganzberg S, Yamazaki S. A comparison of intravenous sedation with two doses of dexmedetomidine: 0.2 mcg/kg/hr versus 0.4 mcg/kg/hr. *Anesth Prog*. 2010;57:96–103.
9. Kamibayashi T, Maze M. Clinical uses of $\alpha 2$ adrenergic agonist. *Anesthesiology*. 2000;93:1345–1349.
10. Newmann MG, Trieger N, Loskota WJ, Jacobs AW. A comparative study of psychomotor effects of intravenous agents used in dentistry. *Oral Surg*. 1970;30:34–40.
11. Sessler CN, Gosnell MS, Grap MJ, et al. The Richmond Agitation-Sedation Scale: validity and reliability in adult intensive care unit patients. *Am J Respir Crit Care Med*. 2002;166:1338–1344.
12. Hall JE, Uhrich TD, Barney JA, Arain SR, Ebert TJ. Sedative, amnestic, and analgesic properties of small-dose dexmedetomidine infusions. *Anesth Analg*. 2000;90:699–705.
13. Kondo T, Suzuki C, Beppu T, et al. Intravenous sedation with midazolam—part 1. Sedation effect. *J Jpn Dent Soc Anesthesiol*. 1983;11:296–308.
14. Galloway FM, Hrdlicka J, Losada M, Noveck RJ, Caruso FS. Comparison of analgesia by intravenous butorphanol and meperidine in patients with post-operative pain. *Can Anesth Soc J*. 1977; 24:90–102.
15. Greenblatt DJ, Locniskar A, Ochs HR, Lauven PM. Automated gas chromatography for studies midazolam pharmacokinetics. *Anesthesiology*. 1981;55:176–179.
16. Smith MT, Heazlewood V, Eadie MJ, Brophy TO, Tyrer JH. Pharmacokinetics of midazolam in the aged. *Eur J Clin Pharmacol*. 1984;26:381–388.
17. Kaneko Y, Kumasaka H, Koyama T, Fuse Y, Kobayashi M, Nakakuki T. Comparative study of midazolam and diazepam for intravenous sedation in dentistry. *J Jpn Dent Soc Anesthesiol*. 1985; 13:410–419.
18. Ebert TJ, Hall JE, Barney JA, Uhrich TD, Colinco MD. The effect of increasing plasma concentrations of dexmedetomidine in humans. *Anesthesiology*. 2000;93:382–394.
19. Oka S, Takahashi M, Tajima A, Kyoda N, Misaki T. A study intravenous sedation with propofol: comparison of propofol alone with concomitant use of inhalation sedation. *J Jpn Dent Soc Anesthesiol*. 2000;28:70–75.
20. Matsuki Y, Ichinohe T, Kaneko Y. Amnesia for electrical dental pulp stimulation and picture recall test under different levels of propofol or midazolam sedation. *Acta Anaesthesiol Scand*. 2007; 51:16–21.
21. Zallen RD, Cobetto GA, Bohmfalk C, Steffen K. Butorphanol/diazepam compared to meperidine/diazepam for sedation in oral maxillofacial surgery: a double-blind evaluation. *Oral Surg Oral Med Oral Pathol*. 1987;64:395–401.
22. Gill SS, Wright EM, Reilly CS. Pharmacokinetic interaction of propofol and fentanyl: single bolus injection study. *Br J Anaesth*. 1990;65:760–765.
23. Simmonds MK, Rashiq S, Sobolev IA, et al. The effect of single-dose propofol injection on pain and quality of life in chronic daily headache: a randomized, double-blind, controlled trial. *Anesth Analg*. 2009;109:1972–1980.

Downloaded from http://meridian.allenpress.com/joi/article-pdf/40/1/94/2039851/aaid-joi-d-11-00200.pdf by guest on 18 October 2021