The Effects of Preoperative Anxiety on Intravenous Sedation

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Anxiety is known to cause feelings of uneasiness, tension, and nervousness, and previous studies have noted that anxiety and its effects may have an effect on outpatient sedation for patients undergoing surgical procedures. In this study, we assess the effects of anxiety on 25 outpatients undergoing intravenous sedation for third molar extraction. Before the procedure, subjects completed the State-Trait Anxiety Inventory, and intraoperative patient movement was assessed using a subjective scale. We found that patients with a high level of preoperative anxiety had a greater degree of average intraoperative movement ($P = .037$) and also required a greater amount of propofol to maintain a clinically acceptable level of sedation ($P = .0273$) when compared with patients with less preoperative anxiety. Increased state anxiety and trait anxiety serve as predictors for an increased total dose requirement of propofol to maintain an acceptable level of sedation ($r^2 = 0.285$, $P = .0060$, and $r^2 = 0.233$, $P = .0146$, respectively). An increased level of trait anxiety was also a predictor of an increased degree of average intraoperative movement ($r^2 = 0.342$, $P = .0022$). Patients who exhibit a high level of preoperative anxiety require a greater total dose of propofol to achieve and maintain a clinically acceptable level of sedation and are more prone to unwanted movement while under sedation.

Key Words: Anxiety; Intravenous sedation.

A nxiety describes an unpleasant emotional state or condition. Anxiety states are characterized by subjective feelings of apprehension, nervousness, tension, and worry when subjected to an anxiety-provoking stimulus, such as going to the dentist or oral surgeon. Anxiety-provoking stimuli also cause a neuroendocrine response that contributes to the anxious state. This neuroendocrine response is associated with characteristic hemodynamic and metabolic effects.[1] The neuroendocrine response to an anxiety-provoking stimulus, along with the subjective feelings of anxiety, makes up the anxiety state of the individual.

Anxiety is also used in psychology to describe individual differences in anxiety proneness as a personality trait (trait anxiety). In contrast to the transitory nature of

emotional states, personality traits are enduring differences among people in reacting or behaving in a certain way with predictable regularity. State anxiety is defined as the subjective feelings of nervousness, apprehension, and tension when one is subjected to an anxiety-provoking stimulus. The trait anxiety of an individual implies differences between people in the disposition to respond to stressful situations with varying amounts of state anxiety.[2] Therefore, it follows that those individuals with higher trait anxiety should respond with an increased state anxiety in a situation that they perceive as hostile or dangerous, an anxiety-provoking situation. Those people in an anxiety-provoking situation have increased subjective feelings of worry and apprehension, as well as a more dramatic neuroendocrine response to the stimulus. This increased neuroendocrine response results in increased cardiovascular activity and a more altered or activated metabolism.[2]

During surgical procedures, many complications can arise. Intraoperative movement is one of these complications. Spontaneous movement, coughing, and hic-

Behavior Grading Scale for Dental Surgical Procedures[6]

Grade	Description
IV1	No uninvited limb movement. Total cooperation and no restlessness.
IV2	Small amount of uninvited limb movement. Still total cooperation and no restlessness.
IV3	More uninvited limb movement. Small degree of restlessness and anxiety. Patient less cooperative. Still able to perform all dental procedures.
IV4	Considerable degree of limb movement. Perhaps also unhelpful head movements. Cooperation poor. Patient quite restless and anxious. Able to perform only basic dentistry. Advanced, delicate work not possible.
IV5	Restlessness, anxiety, and limb movement severe. Impossible to perform any dental surgery.

coughs can occur in unparalyzed patients during the most stimulating portion of a surgical procedure.[3] In tooth extraction procedures, the most stimulating portions would be injection of the local anesthetic, drilling, and other surgical stimuli (incising tissue, developing a flap). It has been shown that larger amounts of anesthetic are required to blunt uninvited intraoperative movement, which could increase the time to anesthetic emergence and procedural costs and may result in increased postoperative emesis.[4]

Studies have also examined a relationship between preoperative anxiety and the amount of anesthetic to maintain adequate anesthesia. It has been shown that high baseline anxiety predicts increased intraoperative anesthetic requirements to maintain a clinically sufficient hypnotic component of the anesthetic state. The finding that these patients require more intraoperative anesthetic suggests that the hypnotic state is clinically insufficient, and the patient may be prone to movement. This has been demonstrated in patients undergoing procedures with administration of general anesthesia.[5] In 1996, Ellis[6] was able to assess the relationship between preoperative anxiety and the amount of intraoperative movement of patients under intravenous sedation. The study used a subjective scale to grade the behavioral characteristics of patients while under intravenous sedation and showed that those who were very anxious were much more prone to movement during the procedure. The purpose of the current study is to evaluate the effects of preoperative anxiety on the amount of sedative medication administered and intraoperative movement in patients receiving intravenous sedation for extraction of third molars.

METHODS

Twenty-five patients of American Society of Anesthesiologists' classification I or II undergoing extraction of at least 2 impacted third molars were studied. Before sedation, patients completed the Spielberger State Trait Anxiety Inventory (STAI). The investigators were blinded to the results of the STAI until after the patient was

dismissed. The scores were then compared with tables of normative data obtained through previous studies of working adults, college students, high school students, and military recruits.[2] During the procedure, bispectral (BIS) analysis was used to maintain a constant depth of sedation at a clinically acceptable level, which was determined from previous studies and by the present researchers to be at a level corresponding to a BIS reading of 70–80.[7]

After preoperative vital signs were recorded, intravenous access was obtained and lactated Ringer's intravenous fluid started, as well as oxygen administration via nasal hood at 3 L/min. Initially, midazolam in 1-mg intravenous boluses was given until the Verrill sign (bilateral upper eyelid ptosis) was achieved (dose is approximately 0.05 mg/kg of lean body weight). Fentanyl was given in 50-μg boluses for a total of approximately 1.5 μg/kg of lean body weight. Propofol was then given in 10- to 20-mg boluses until a clinically desirable sedation level was achieved (BIS level of 70–80). The total amount of medications given and the time were recorded. Additional sedative-hypnotic agents (midazolam and/or propofol) were administered to maintain a BIS level of 70–80. The time and dose of the bolus given were recorded to study the effect of these additional boluses on the indices.

All patients had preoperative baseline and continuous intraoperative vital signs monitored with pulse oximetry, precordial stethoscope, automated and continuous noninvasive blood pressure measurements using the Vasotrac (Medwave, St Paul, Minn), electrocardiogram, and respiratory rate. Changes in vital signs, such as elevation of blood pressure or pulse, and evidence of patient movement were used as markers of potential stress-related pain or other source of intraoperative stimulation. Episodes of patient movement were graded subjectively with the behavior grading scale (Table) at times of unwanted patient movement and when medications were administered. Each patient had a different number of episodes graded based on the patient's degree of movement throughout the procedure and the frequency of drug administration. The grading was performed by the
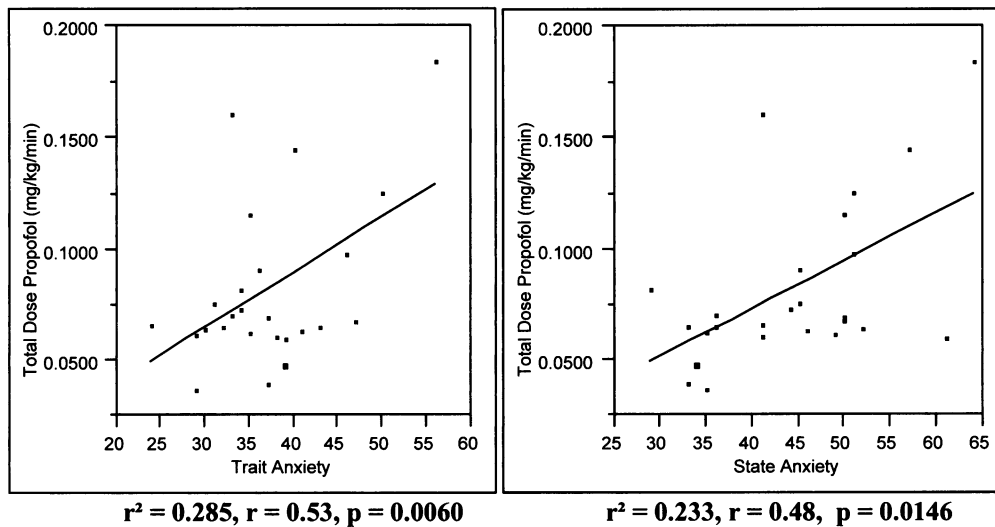
$r^2 = 0.285, r = 0.53, p = 0.0060$

$r^2 = 0.233, r = 0.48, p = 0.0146$

Figure 1. State anxiety and trait anxiety demonstrated as continuous predictors of an increase in total dose requirement of propofol to maintain a clinically acceptable level of sedation.

investigator administering the medications to the patient.

Based on STAI scores, subjects were divided into high- and low-anxiety groups; patients with a state anxiety score of 50 or more were considered to have a high level of preoperative anxiety. In one analysis, we considered whether there was a difference in the dose of propofol administered to patients with state anxiety scores of 50 or more and those with state anxiety scores of 49 or less. We also considered whether there was a difference in the degree of intraoperative movement in subjects with high-state ($\geq$50) versus low-state anxiety. We then considered state and trait anxiety as continuous predictors of the total dose requirement of propofol and continuous predictors of the degree of average intraoperative movement. Statistical analysis of results was calculated using the standard t test and linear regression analysis.

RESULTS

State and trait anxiety scores have been analyzed for the 25 patients in this study. As expected, state and trait anxiety correlated with one another ($r = 0.48$, $P = .016$). In this study, 9 of the 25 patients were found to have a high level of anxiety before their surgical procedure (state anxiety score $\geq$50). The average state anxiety score was 44.36 (range, 29–64), whereas the average trait anxiety score was 37.12 (range, 29–56). State and trait anxiety were further analyzed to assess the potential relationship among individual subjects' anxiety, the total dose of propofol administered in the

procedure, and the patients' degree of intraoperative movement.

Total doses of sedative medications were also recorded in all subjects. The average doses of fentanyl and midazolam were calculated before the procedure on a per weight basis and varied little among subjects. No additional doses of fentanyl were administered during any procedure, and only one patient required an additional dose of midazolam. Because of the large variability of dose of propofol administered, we therefore calculated total average dose administered to compare the doses of subjects, accounting for patient weight and time of procedure. The average dose of propofol administered was 0.0822 mg/kg per minute (range, 0.037–0.185 mg/kg per minute).

In one analysis, patients with a high level of preoperative anxiety (state anxiety score $\geq$50) required a greater amount of propofol to maintain a clinically acceptable level of sedation ($P = .0273$) when compared with patients with less preoperative anxiety. We have also noted (Figure 1) that an increased level of state anxiety serves as a predictor for an increased total dose of propofol required to maintain a clinically acceptable level of sedation ($r^2 = 0.285$, $P = .0060$), a finding that was also seen in patients with an increased level of trait anxiety ($r^2 = 0.233$, $P = .0146$).

In analysis of the amount of intraoperative movement, the scores of movement of each subject were averaged and compared. The average amount of intraoperative movement was 1.77 (range, 1–3.3) of 5. Patients with a high level of preoperative anxiety (state anxiety score $\geq$50) were found to have a greater degree of average intraoperative movement ($P = .037$). As is

$$r^2 = 0.342, r = 0.58, p = 0.0022 \qquad r^2 = 0.143, r = 0.38, \ p = 0.0621$$
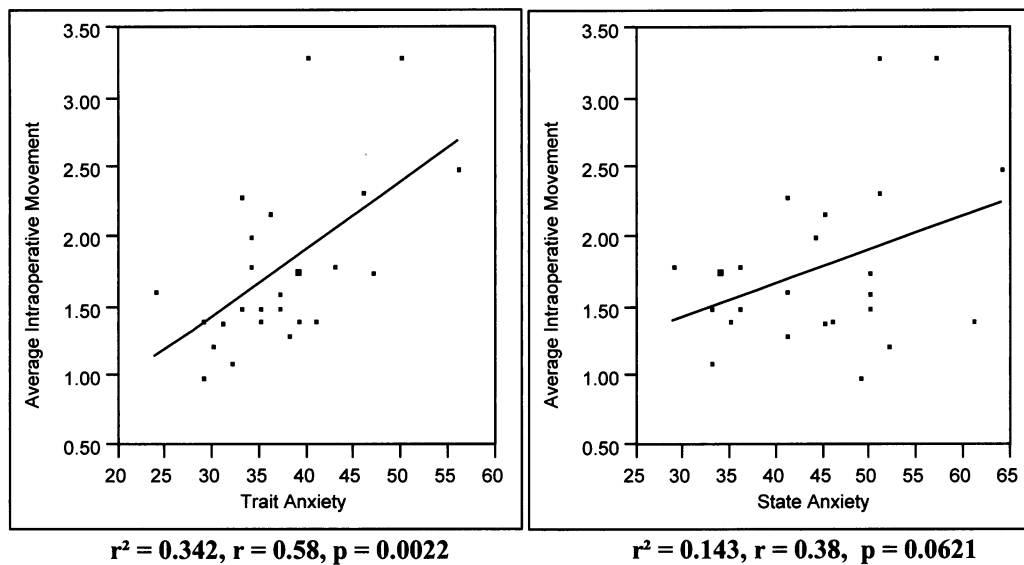
Figure 2. State and trait anxiety as continuous predictors of increased intraoperative movement. Only trait anxiety serves as a significant predictor of increased intraoperative movement.

demonstrated in Figure 2, an increased level of trait anxiety was also seen as a predictor of an increased degree of average intraoperative movement ($r^2 = 0.342$, $P = .0022$). An increased level of state anxiety did not serve as a significant predictor of increased intraoperative movement ($r^2 = 0.143$, $P = .0621$).

DISCUSSION

In this study, our goal was to assess the relationship between the total amount of sedative medications necessary for intravenous sedation and the level of preoperative anxiety, while controlling for the level of sedation in patients undergoing third molar extraction. We also assessed the relationship between preoperative anxiety and the degree of patient's intraoperative movement.

The levels of midazolam and fentanyl administered to each patient were constant due to the adjustment of doses based on weight. Only one patient required an additional dose of midazolam after the initial sedation. This was due to an inability to get a deeper level of sedation (BIS reading below 80) without administering extra midazolam. The administration of propofol was given on an individual basis with use of BIS analysis to help control for the level of sedation.

Past studies have looked at the relationship between anxiety and intraoperative anesthetic requirements. Maranets and Zeev[8] studied the effects of preoperative anxiety on intraoperative anesthetic requirements for patients undergoing general anesthesia for bilateral laparoscopic tubal ligation. They found that state anxiety (measured by the STAI) is not associated with increased

intraoperative anesthetic requirements, but trait anxiety serves as a predictor of increased intraoperative anesthetic requirements.[8]

In the current study, we found that both state and trait anxiety served as predictors of increased intraoperative anesthetic requirements. There are procedural differences between the study by Maranets and Zeev and the current study and therefore different degrees of intraoperative stimulation. The anesthetic techniques are also very different in the study by Maranets and Zeev compared with the current study (general anesthesia vs intravenous sedation, respectively). In the study by Maranets and Zeev, general anesthesia with endotracheal intubation was achieved, as well as a greater depth of anesthesia (BIS reading of 40–60). It is possible that the difference in anesthetic techniques and degree of anesthesia between the study by Maranets and Zeev and the current study are the reason for the different results. The greater depth of anesthesia in the study by Maranets and Zeev may have led to a masking of the effects of state anxiety on anesthetic requirements, whereas in the current study, the lighter depth of anesthesia allowed the effects of state anxiety to be manifested.

Goldman et al[9] studied preoperative anxiety in relation to intraoperative anesthetic requirements of alfentanil and methohexitone in women undergoing general anesthesia for gynecological surgery. This study reported increased anesthetic requirements correlated with increased state anxiety, but the results were nonsignificant, whereas in the present study the findings were significant. In the study by Goldman et al, there was no control for the depth of anesthesia, the type of proce-

dure was not constant, and there was no use of a validated measurement tool of state anxiety.[9] In the present study, we were able to control for the depth of anesthesia and type of procedure, as well as using a validated tool to measure state anxiety.

The present methods used to measure the level of patient sedation are often based on the subjective observation of the anesthetist, and clinical scoring methods are commonly used (eg, the Observers Assessment of Alertness/Sedation). Other methods, such as the electroencephalogram, are highly complex and difficult to interpret. By using subjective or highly complex means to assess depth sedation, it is difficult to determine exact anesthetic requirements and to maintain a constant level of sedation.[8]

In this study, we chose to use BIS analysis to control for the level of sedation. The application of BIS technology to the field of anesthesiology has helped to gain real-time information into some of the complex changes that occur in the brain secondary to the use of sedative medications. Specifically, BIS analysis has been demonstrated to be useful as a pharmacodynamic measure of the level of responsiveness of the patient (ie, response to verbal command, gentle stimulation, painful stimulation) and particularly sensitive in predicting the loss of consciousness. Although few studies have been performed on sedated patients, BIS analysis has been noted to correlate with the clinically observed level of sedation in those patients.[7,10–12] Use of BIS analysis allows for comparison of the amounts of sedative medications necessary to maintain the same hypnotic state or level of sedation.

By using BIS analysis, real-time information is available relative to the level of hypnosis, and there is no need to stimulate the patient to subjectively assess the level of sedation. In the current study, not having to stimulate the patient to assess the depth of sedation was advantageous because one of the variables looked at was the amount of intraoperative movement.

In 1996, Ellis[6] assessed the effects of preoperative anxiety on the amount of intraoperative movement and cooperation of patients undergoing intravenous sedation with midazolam for dental procedures. This study showed that only 49% of the subjects in the highest anxiety group were in the most favorably cooperative group (IV1). The study also showed that the least anxious subjects were in the most cooperative group (all of the least anxious in the IV1 group). Based on these studies, Ellis concluded that the more anxious a patient, the more likely he or she is to exhibit intraoperative movement and be less cooperative. In the present study, we showed that patients with high preoperative anxiety are significantly more prone to intraoperative movement. The shortcoming of the Ellis study is that it did not use

a validated tool to measure anxiety, such as the STAI, which was used in the current study.

When we applied the STAI in the current study, we showed that trait and not state anxiety was a significant predictor of increased intraoperative movement. Perhaps trait anxiety is a predictor because it represents an individual's underlying tendency to perceive a situation as hostile or dangerous. Perhaps state anxiety did not serve as a predictor of increased intraoperative movement because the level of sedation used in the procedures was sufficient to blunt the unwanted intraoperative movement.

For all patients in this study, all procedures were completed regardless of the degree of patient movement. In only 2 patients was it necessary to stop the procedure temporarily due to patient movement. These patients were given additional medication and the procedure was continued. One can anticipate that the patient's degree of intraoperative movement would have an impact on the surgeon's and the patient's satisfaction with the procedure and sedation. One limitation of our study is that no formal assessment of patient and surgeon satisfaction was performed.

There are some other limitations in our study design that must be addressed. In the sedation procedure, a per body weight dosage schedule was used, which has been shown to be unreliable due to high interindividual variability.[13] In the current study, there is also administration of either 10- or 20-mg boluses of propofol in response to an increase in BIS value (ie, in response to a decrease in depth of sedation). Many studies have demonstrated variability in the control of the level of sedation due to interindividual variability in the dose requirements of propofol.[14–16] This variability in dose requirement may lead to oversedation and therefore a potential suppression of the response to anxiety and intraoperative stimuli.[17] It was noted in the review of the results that some patients were not given additional propofol and were allowed to reach a lighter degree of sedation (BIS reading >80) just before the end of the procedure. Conversely, other patients received additional doses of propofol shortly before the end of their procedure, which may have led to suppression of the response to anxiety and increased recovery time. The benefit of using propofol in the sedation procedure of the current study is that if oversedation occurs, the optimal level of sedation can be restored quickly (usually within 1 minute) by decreasing the dosage.[17]

Another disadvantage of the current study is the inherent variability in duration and complexity of third molar extraction procedures. Because of the variation in complexity, some cases will require more extensive bone removal or development of a flap. These variations will result in various degrees of surgical stimulation. To

minimize the variation in the current study, we have only included subjects who are undergoing extraction of at least 2 impacted third molars. In this study, there were also different operators who performed the procedures. All operators were junior or senior oral and maxillofacial surgery residents at the same institution, and the same faculty member oversaw all procedures. One way to improve the study design would have been to have only one operator perform all procedures.

The data suggest that a patient with an increased level of state or trait anxiety before a surgical procedure will require an increased amount of sedative medication to induce and maintain a clinically acceptable level of sedation. The data also suggest that the more anxious a patient in the preoperative period, the more prone he or she is to movement during the surgical procedure. By knowing that patients who are highly anxious will require more medication for sedation and are more prone to move during the procedure, we can use anesthetic techniques that will allow for deeper sedation to keep the patient comfortable and prevent potentially harmful intraoperative movement.

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