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PATIENT SAFETY NETWORK

Intraoperative Awareness during Rhinoplasty

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Learning Objectives

At the conclusion of this educational activity, participants should be able to:

- Describe the risk factors for intraoperative awareness.
- Identify the clinical signs of depth of anesthesia.
- List the drugs associated with awareness.
- Recognize the potential for developing post-traumatic stress syndrome.
- Describe the approaches to prevent awareness.

The Case

A 33-year-old woman in good physical health presented to the hospital for elective rhinoplasty. During the operation, she became aware that she was awake. She heard the conversation among the surgical team members and felt pressure on bone in her nose, but she did not feel pain. The patient also felt that the

breathing tube was pushed up against the inside of her throat, impeding her ability to breathe. She was unable to move but recalls making a “monumental effort” to utter a small groaning noise, which alerted the surgeon to the fact that she was awake. She heard the surgeon verbally acknowledge her condition and offer reassurance that the operation was almost over. It was her impression that the surgeon rushed to finish the operation while full anesthesia was restored, and she later awoke in the recovery room without complications. During the first follow-up visit, the surgeon did not address the situation, so the patient brought it up at the end of the visit. The surgeon seemed surprised and embarrassed that the patient remembered waking up during the operation but could not explain what happened.

The Commentary

By Christian Bohringer, MBBS, and Jaijeet Toor, MD

Background

Awareness under anesthesia during surgical procedures is an uncommon event. The incidence has been estimated to vary widely, with estimates ranging from 1 in 500 to 1 in 19,000 anesthetic administrations.[1,2] About 20% of awareness episodes occur near the end of the procedure, as in this case.[3] Anesthesia care professionals are aware of the problem, and they carefully monitor every patient for signs of inadequate depth of anesthesia.[4] Unintended episodes of awareness are therefore related to anesthesia management rather than the operation or surgeon. If the patient moves unexpectedly during the procedure, the surgeon should stop cutting or manipulating tissue, and give anesthesia staff the opportunity to deepen sedation so that intraoperative awareness can be avoided.

In the past, anesthesiologists relied solely on clinical signs, such as pupil diameter, blood pressure, heart rate, respiratory rate, tidal volume and patient movement, to judge the depth of anesthesia. However, these clinical signs often fail to detect awareness. A closed claims analysis reported 61 cases of awareness during general anesthesia; only 9 of these cases were associated with hypertension, 4 with tachycardia, and 1 with movement.[5]

The introduction of neuromuscular blocking agents (NMBAs) into clinical anesthesia in the 1940s was a major advance. These drugs greatly facilitate endotracheal intubation and provide adequate muscle relaxation without requiring very high sedative doses that can precipitate cardiovascular depression and cardiac arrest.[6] Neuromuscular blocking drugs therefore greatly enhance patient safety when anesthetizing patients with significant cardiopulmonary disease. However, these drugs also significantly increase the incidence of awareness under anesthesia because paralyzed patients cannot move to indicate that they are not sufficiently sedated.[7] When patients undergo general anesthesia without NMBAs, they will move if they start waking up unexpectedly. This movement is noticed immediately by the surgeons because they cannot continue with the operation. Additional anesthetic agents are then given to stop the patient from moving. Memory of this type of event after the operation is uncommon because patients usually start moving in response to surgical stimulation before they are sufficiently awake to remember the episode. The incidence of awareness under anesthesia is therefore about two thirds lower when NMBAs are avoided.[5]

Most of the clinical signs of inadequate depth of anesthesia are produced by activation of the sympathetic nervous system.[8] These signs may be absent in several clinical circumstances. High blood pressure and tachycardia may be masked when the patient is treated with beta blockers or other anti-hypertensive medications. When blood loss is not replaced concurrently with intravenous fluid, hypertension may also be absent during episodes of awareness. Tachypnea and increased minute ventilation are abolished by NMBAs. However, increased diameter of the pupils (mydriasis) is another clinical sign of sympathetic nervous system activation[9] that is still present when the patient is paralyzed because the smooth muscle of the iris is not affected by NMBAs. Pupillary diameter therefore increases in response to adrenaline secretion even when the patient is completely paralyzed. Tear formation and diaphoresis are additional signs of sympathetic activation. The frontalis muscle of the forehead is very resistant to NMBAs. For this reason, patients can still frown their forehead muscles even when most other skeletal muscles are profoundly paralyzed. Excessive frowning, tearing or diaphoresis are signs of inadequate depth of anesthesia. Manufacturers of forced air warming blankets construct the face portion of the blanket as a see-through plastic membrane to allow anesthesia professionals to monitor the patient's face during the procedure.

Processed electroencephalography (EEG) is another method to monitor the depth of anesthesia; these monitors have been available for some time.[10,11] The Bispectral Index (BIS) and brain function monitors measure electrical activity in the brain to help judge the depth of anesthesia. EEG monitoring has been associated with reduced incidence of intraoperative awareness in some studies,[12,13,14] but episodes of awareness have occurred even when these monitors were used.[15] Recently, these monitors have been advocated for reducing drug costs as well as for preventing oversedation and speeding recovery times in the post-anesthesia care unit.[16,17] When used with this intent, however, EEG monitoring could inadvertently lead to increasing episodes of awareness. The clinical signs of depth of anesthesia should therefore always be assessed, and processed EEG monitors should only be used as additional data points to evaluate the complete clinical picture.

Awareness under anesthesia is more common in young patients taking medications for seizures or patients who use recreational drugs.[18] Exposure to sedative medications induces liver enzymes and increases tolerance to anesthetic agents. Patients with a previous history of awareness during general anesthesia are also at increased risk. When giving midazolam or dexmedetomidine for preoperative anxiolysis, the anesthesiologist should evaluate the effect of these medications on each patient individually. Assessing the impact of preoperative anxiolytic medications helps anesthesia clinicians judge the amount of anesthesia drugs necessary for preventing awareness in that patient. Rigid anesthesia protocols or "cookbooks" that use the same dose of drug for every patient on a mg/kg basis should be avoided.

Awareness is also more common during emergency operations for acute trauma. In this setting, blood pressure and cardiac output may be low from uncorrected hypovolemic shock, limiting how much sedative medication can be given to a patient without precipitating cardiac arrest. Hypovolemia must be treated with fluids and vasopressors first, so that it becomes safe to give more anesthetic agents. It is good practice to talk to the paralyzed patient to let them know that the anesthesia team is aware that they may be awake but unable to move. This is important because many patients think that they had a stroke when they are not able to move. Verbal communication provides reassurance. The patient should be told they will receive additional sedation as soon as it is safe. Trauma anesthesia care has been improving over time; a recent

study found that awareness in trauma patients is not as common as it used to be.[19] Cardiac surgery is also associated with higher incidence of awareness because high dose opioid anesthesia is often used to prevent cardiovascular depression. Opioids do not provide the same level of amnesia as anesthetics administered by inhalation.[20]

Total intravenous anesthesia with a propofol infusion is also associated with a higher incidence of intraoperative awareness than a volatile anesthetic such as sevoflurane.[21] Anesthesia professionals are especially vigilant about monitoring ventilation to prevent hypoxic events. Thus, when anesthesia delivery is linked to ventilation, it is less likely to be overlooked. However, inadvertent kinking of the endotracheal tube can occur during ear, nose and throat operations, because the face and endotracheal tube are covered by sterile surgical drapes and the tube can be kinked by accidentally leaning on it. A sudden increase in airway pressure should prompt the anesthesia care professional to rule out a kinked endotracheal tube. Intravenous anesthesia comes with the inherent risks of disconnection at a Luer lock, tissue infiltration of the intravenous cannula, infusion pump malfunction, an empty infusion bottle, a kinked infusion line, and propofol refluxing up into another line that has been piggybacked onto the primary infusion line. When total intravenous anesthesia is used, it is necessary to have an anti-reflux valve in the infusion tubing. It is preferred to infuse propofol through its own dedicated intravenous cannula via a dedicated infusion pump.

Patients who have awareness under anesthesia while paralyzed may develop post-traumatic stress disorder.[22,23] This is especially common after cesarean delivery under general anesthesia because opioid medications are withheld from the mother until delivery to limit respiratory depression in the newborn. When the patient suffers awareness and feels severe pain while unable to move, the psychological effects may be worse than from episodes of awareness without pain. Cardiovascular surgery patients tend to have fewer psychological sequelae because they are usually treated with high doses of opioids and do not recall any pain.

When a patient mentions that they remember intraoperative events, they should be seen by their anesthesiologist. A careful history should be taken to establish what the patient remembers. It is important to validate the patient's experience. Claims of awareness should not be brushed aside as mere imagination by the patient. Details of what is recalled should be elicited and compared with what happened during the operation. The anesthesia record should be reviewed for evidence of inadequate depth of anesthesia. Patients usually resent their care team if nobody believes them and if staff belittle the suffering they experienced while aware. Acknowledging the episode of awareness and helping the patient come to terms with their experience can help to resolve the patient's dissatisfaction and anger. When features like excessive fear, lack of sleep and constant reliving of the intraoperative experience occur, the patient may benefit from consultation by a psychiatrist for ongoing treatment of post-traumatic stress syndrome.[24]

Finally, it is important to recognize that some cases of awareness are intended, as part of the plan of care. Sometimes a confused patient receives a spinal anesthetic during surgery for a hip fracture. If the patient's cognition is simultaneously impaired by opioid pain medications, the patient may not remember that the anesthetic plan involved a spinal anesthetic with minimal sedation to avoid cardiovascular depression. It is therefore very important to review the anesthetic record to understand what happened.

Approaches to Improving Patient Safety

Increase the amount of anesthetic for physically active patients

Young patients who are physically fit often require higher anesthetic dosing than older or more frail patients to prevent awareness. Patients with more muscle mass may awaken from intravenous anesthetic induction because propofol redistributes out of the brain to skeletal muscle.

Assess the effect of preoperative anxiolytic medication

The effect of midazolam or dexmedetomidine given for preoperative anxiolysis should be carefully evaluated to determine the patient's sensitivity to central nervous system depressant drugs. If the patient requires high doses to alleviate preoperative anxiety, it is likely that they will need more medication to prevent intraoperative awareness.

Anticipate increased anesthetic requirement for patients taking sedative medications

Patients who are taking anticonvulsants, anxiolytics like benzodiazepines, analgesics like opioids, or recreational drugs like alcohol and marijuana typically require increased amounts of anesthetic drugs to remain unconscious.[25] However, there are exceptions to this principle, and clinicians should pay close attention to the effect of preoperative anxiolytic medications to minimize any implicit bias related to treatment of substance users.

Carefully evaluate the clinical signs of depth of anesthesia

Heart rate, blood pressure, pupil diameter, and the tone of the frontalis muscle should be carefully monitored throughout the operation. Changes in respiration are also a sign of depth of anesthesia but can only be assessed if the patient is not paralyzed. Blood loss should be replaced urgently. When the patient is paralyzed, vasoactive medications like beta blockers and vasodilators should only be given after insufficient depth of anesthesia has been ruled out as the cause for tachycardia and hypertension. When pupil diameter remains large, hypertension is best treated with additional anesthesia drugs that have amnestic properties.

Consider using benzodiazepines instead of neuromuscular blocking drugs in patients with previous awareness

When patients are not paralyzed, they can move if they unexpectedly wake up from anesthesia before the end of the procedure. Avoiding paralysis enhances the anesthesia provider's ability to recognize intraoperative awareness. In a recent metanalysis, the use of intravenous benzodiazepines was associated with a reduced incidence of intraoperative awareness.[26]

Take special precaution with intravenous anesthesia

Propofol infusions carry a greater risk of awareness than inhaled sevoflurane. A well-functioning intravenous line with an anti-reflux valve is necessary. All Luer lock connections should be tightened carefully to prevent inadvertent disconnection. Propofol should preferably be infused directly into its own designated intravenous canula to prevent bolus administration when giving other fluids through the same line, and to eliminate the risk of propofol refluxing into another infusion line.

Consider intraoperative processed EEG monitoring

Processed EEG monitoring is often used during total intravenous anesthesia because the context sensitive half-life of propofol (i.e., the time for propofol's blood plasma concentration to decline by half after a steady state infusion is stopped) increases with longer duration of surgery, which can lead to slower emergence from anesthesia. Processed EEG monitoring can also help to prevent intraoperative awareness. EEG monitoring should be considered especially in patients who had a previous episode of intraoperative awareness or when total intravenous anesthesia is planned.[27,28] Every anesthetic drug has its own signature on the processed EEG tracing and the combination of anesthesia drugs creates a unique pattern. Ketamine is a dissociative anesthetic and has a distinctive effect on the EEG. When ketamine is used, the brain function monitor looks as if the patient is waking up from anesthesia. It is therefore critical to review all administered drugs to avoid misinterpreting the processed EEG signal.

Kinking of the endotracheal tube (ETT) should be recognized early

Any operation on the head or neck is associated with the risk of unintentionally kinking the ETT. This obstruction can be from external pressure applied by surgical instruments or by the operator accidentally leaning against the ETT. A sudden rise in airway pressure should prompt the anesthesia care professional to rule out this potential problem. The patient in this Case describes the sensation of not receiving adequate ventilation while she was intubated and awake. Her interpretation that the ETT was obstructed by external pressure is very plausible. This obstruction could not have been caused by her biting down on the ETT because she was still paralyzed when she regained consciousness during the operation.

Anesthesia should not be terminated before the end of the operation

This patient reportedly awoke before the operation was completed, and it was her impression that the surgeon rushed to finish the operation, potentially leading to a suboptimal result. Production pressure in the operating room should never lead clinicians to deliver suboptimal care to reduce anesthesia time or turnover time. The neuromuscular block should be reversed before anesthetic agents are withdrawn, allowing the patient to move in case the depth of anesthesia is insufficient for the intensity of the surgical stimulation.

The patient's experience of awareness should be validated

It is very important to believe the patient when they talk about recollections of intraoperative events. It will be obvious if the patient truly remembers things that happened during the procedure. When anesthesia professionals pretend that the patient only imagined the events, it often leads to resentment and may increase the provider's legal risk. If the patient shows features of post-traumatic stress syndrome, a psychiatry consult may be helpful. Having an honest conversation with the patient helps them to understand the event and process their experience.

Episodes of awareness should be clearly flagged in the medical record

Any episode of awareness should be highlighted in the electronic medical record and placed on the snapshot page so that this information is readily accessible to future anesthesia care providers. Knowledge of a previous awareness event can help avoid another episode in the future. In a patient with a prior

episode of awareness, clinicians should err on the side of oversedation and accept a slightly longer wake up time to minimize the likelihood of the patient remembering pain and paralysis while on the operating room table.

Take-Home Points

- The dose of anesthesia needs to be titrated for every patient individually.
- Anesthesia clinicians are principally responsible for preventing awareness during invasive procedures.
- Clinical signs of depth of anesthesia need to be assessed continuously.
- Processed EEG monitoring can reduce the incidence of awareness.
- Awareness occurs more often when propofol infusion or neuromuscular blocking drugs are used, compared with general inhalational anesthesia alone.
- The risk of awareness is reduced with benzodiazepines.
- The patient's experience of awareness should be validated and addressed honestly.
- A psychiatrist should be consulted if there are symptoms of post-traumatic stress syndrome.
- Episodes of intraoperative awareness should be highlighted in the medical record and included in the snapshot.

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References

1. Pandit JJ, Andrade J, Bogod DG, et al. 5th National Audit Project (NAP5) on accidental awareness during general anaesthesia: summary of main findings and risk factors. *Br J Anaesth*. 2014;113(4):549-559. [Free full text]
2. Sebel PS, Bowdle TA, Ghoneim MM, et al. The incidence of awareness during anesthesia: a multicenter United States study. Anesth Analg. 2004;99(3):833–839. [Free full text]
3. Cascella M, Bimonte S, Amruthraj NJ. Awareness during emergence from anesthesia: Features and future research directions. *World J Clin Cases*. 2020;8(2):245-254. [Free full text]
4. Chung HS. Awareness and recall during general anesthesia. *Korean J Anesthesiol*. 2014;66(5):339-345. [Free full text]

5. Domino KB, Posner KL, Caplan RA, et al. Awareness during anesthesia: a closed claims analysis. *Anesthesiology*. 1999;90(4):1053-1061. [Free full text]
6. Gulenay M, Mathai JK. Depolarizing Neuromuscular Blocking Drugs. 2023 May 1. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan–. [Free full text]
7. Sandin RH, Enlund G, Samuelsson P, et al. Awareness during anaesthesia: a prospective case study. *Lancet*. 2000;355(9205):707-711. [Available at]
8. Laferrière-Langlois P, Morisson L, Jeffries S,et al. Depth of anesthesia and nociception monitoring: current state and vision for 2050. *Anesth Analg*. 2024;138(2):295-307. [Available at]
9. Tank AW, Lee Wong D. Peripheral and central effects of circulating catecholamines. *Compr Physiol*. 2015;5(1):1-15. [Available at]
10. Purdon PL, Sampson A, Pavone KJ, et al. Clinical electroencephalography for anesthesiologists: Part I: Background and basic signatures. *Anesthesiology*. 2015;123(4):937-960. [Free full text]
11. Bouafif L. Monitoring of anesthesia by Bispectral Analysis of EEG Signals. *Comput Math Methods Med*. 2021;2021:9961998. [Free full text]
12. Myles PS, Leslie K, McNeil J, et al. Bispectral index monitoring to prevent awareness during anaesthesia: the B-Aware randomised controlled trial. *Lancet*. 2004;363(9423):1757-1763. [Available at]
13. Kertai MD, Whitlock EL, Avidan MS. Brain monitoring with electroencephalography and the electroencephalogram-derived bispectral index during cardiac surgery. *Anesth Analg*. 2012;114(3):533-546. [Free full text]
14. Zhang C, Xu L, Ma YQ, et al. Bispectral index monitoring prevent awareness during total intravenous anesthesia: a prospective, randomized, double-blinded, multi-center controlled trial. *Chin Med J (Engl).* 2011;124(22):3664-3669. [Free full text]
15. Lee J, Park C, Kim S. Awareness during general anesthesia despite simultaneous bispectral index and end-tidal anesthetic gas concentration monitoring. *Yeungnam Univ J Med*. 2019;36(1):50-53. [Free full text]
16. Sudhakaran R, Makkar JK, Jain D, et al. Comparison of bispectral index and end-tidal anaesthetic concentration monitoring on recovery profile of desflurane in patients undergoing lumbar spine surgery. *Indian J Anaesth*. 2018;62(7):516-523. [Free full text]
17. Chaudhuri S, Banerjee S, Chattopadhyay U, et al. Comparison of recovery times by using bispectral index monitoring versus end-tidal agent concentration monitoring in patients undergoing inhalational general anaesthesia. *Indian J Anaesth*. 2022;66(Suppl 3):S161-S168. [Free full text]
18. Bischoff P, Rundshagen I. Awareness under general anesthesia. *Dtsch Arztebl Int*. 2011;108(1-2):1-7. [Free full text]
19. Lambert DH, Mustafa W, Rendon LF, et al. Awareness during anesthesia for trauma: has anything changed? *Anesth Analg*. 2024;138(4):e19-e20. [Available at]
20. Serfontein L. Awareness in cardiac anesthesia. *Curr Opin Anaesthesiol*. 2010;23(1):103-108. [Available at]
21. Yu H, Wu D. Effects of different methods of general anesthesia on intraoperative awareness in surgical patients. *Medicine (Baltimore).* 2017;96(42):e6428. [Free full text]
22. Fuller BM, Driver BE, Roberts MB, et al. Awareness with paralysis and symptoms of post-traumatic stress disorder among mechanically ventilated emergency department survivors (ED-AWARENESS-

2 Trial): study protocol for a pragmatic, multicenter, stepped wedge cluster randomized trial. *Trials*. 2023;24(1):753. [Free full text]
23. Bruchas RR, Kent CD, Wilson HD, et al. Anesthesia awareness: narrative review of psychological sequelae, treatment, and incidence. *J Clin Psychol Med Settings*. 2011;18(3):257-267. [Available at]
24. Osterman JE, Hopper J, Heran WJ, et al. Awareness under anesthesia and the development of posttraumatic stress disorder. *Gen Hosp Psychiatry*. 2001;23(4):198-204. [Free full text]
25. Beaulieu P. Anesthetic implications of recreational drug use. *Can J Anaesth*. 2017;64(12):1236-1264. [Available at]
26. Wang E, Belley-Côté EP, Young J, et al. Effect of perioperative benzodiazepine use on intraoperative awareness and postoperative delirium: a systematic review and meta-analysis of randomised controlled trials and observational studies. *Br J Anaesth*. 2023;131(2):302-313. [Free full text]
27. von Dincklage F, Jurth C, Schneider G, et al. Technical considerations when using the EEG export of the SEDLine Root device. *J Clin Monit Comput*. 2021;35(5):1047-1054. [Free full text]
28. Carrai R, Martinelli C, Baldanzi F, et al. Is the Patient State Index a reliable parameter as guide to anaesthesiology in cranial neurosurgery? A first intraoperative study and a literature review. *Neurophysiol Clin*. 2023;53(5):102910. [Available at]

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