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## Intraoperative Awareness with Propofol-Oxygen Total Intravenous Anesthesia for Microlaryngeal Surgery

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Microlaryngeal surgery represents a dynamic clinical challenge for both the otolaryngologist and the anesthesiologist. The need to manage the airway cooperatively has led to the development of innovative anesthetic techniques using jet venturi ventilation and total intravenous (iv) anesthesia (TIVA).<sup>1</sup> Propofol (2,6-diisopropylphenol) is an iv anesthetic with well-described characteristics that make it particularly amenable for use in such cases.<sup>2,‡</sup> Recently, however, we encountered a case of intraoperative awareness during TIVA with jet venturi ventilation for laser laryngoscopy using propofol as the sole anesthetic agent.

### CASE REPORT

A 46-yr-old, 72-kg man in otherwise good health presented for outpatient carbon dioxide laser treatment of recurrent vocal cord papillomas. He had no drug allergies, took no medication, used alcohol socially, and had previously undergone many identical procedures using a TIVA (methohexital and succinylcholine infusions)-jet venturi ventilation technique without complications. As was his habit, the patient

requested an anesthetic compatible with rapid recovery and early discharge. He also refused preanesthetic medication.

In the operating room, iv access and routine anesthetic monitoring were established. Initial blood pressure was 137/80 mmHg, and heart rate was 82 beats/min. After administration of glycopyrrolate 0.2 mg iv, induction proceeded with 150 mg (2.1 mg · kg<sup>-1</sup>) propofol and 120 mg succinylcholine followed immediately by a propofol infusion *via* infusion pump at 200 µg · kg<sup>-1</sup> · min<sup>-1</sup>. Hemodynamics after induction remained stable at preinduction levels. Suspension of the larynx and initiation of oxygen-driven proximal jet venturi ventilation as described by Koufman *et al.*<sup>1</sup> was accompanied by hypertension (200/105 mmHg) and tachycardia (122 beats/min), which quickly returned to baseline after a single 5-mg dose of labetalol iv. Anesthetic maintenance consisted of propofol infusion continued at 200 µg · kg<sup>-1</sup> · min<sup>-1</sup> combined with neuromuscular paralysis using a succinylcholine infusion and titrated to 0/4 twitches by train-of-four stimulation of the ulnar nerve. The remainder of the intraoperative course was uneventful. Case duration was 25 min, during which the patient received a cumulative (induction plus maintenance) propofol dose of 450 mg. Emergence from anesthesia was rapid and smooth without hemodynamic perturbations or respiratory compromise.

Upon entering the postanesthesia care unit, the patient spontaneously exclaimed, "I remember all of this one." He described detailed accounts of intraoperative events, such as the surgeon's request for more neuromuscular paralysis because of vocal cord movement and a later request from the surgeon for a spatula to remove burn tissue from the larynx. The patients denied any intraoperative discomfort, including pain or shortness of breath, and remarked that the experience had been quite interesting because "now I know what you guys do to me every 6 weeks."

Close follow-up over the subsequent 18 months revealed the patient to be doing well. He continues to be meaningfully employed and has no psychological problems or sleep disturbances related to this incident.

### DISCUSSION

The abolition of memory for intraoperative events (*i.e.*, amnesia) is an integral and desirable component of propo-

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‡ White PF: Propofol: Pharmacokinetics and pharmacodynamics. *Seminars in Anesthesia* 7:4-20, 1988.

erly administered general anesthesia. The concept of memory as a complex neural function involving anatomic structures, cellular components, molecular elements, and psychological constructs has been the topic of a number of recent publications; most evidence suggests that learning and its inhibition under anesthesia remain poorly understood.<sup>3-8</sup>

The incidence of awareness under general anesthesia is reported to be less than 1%,<sup>3,9,10</sup> although its true incidence may be substantially greater (especially in specific patient populations or with certain anesthetic techniques).<sup>4,6,9</sup> Regardless of its incidence, the overriding issue concerning intraoperative recall involves the immediate effects (pain, lack of control, inability to communicate) as well as long-term psychological effects (anxiety, depression, sleep disturbances) associated with this event.<sup>6,9</sup> Some experts consider awareness under anesthesia to constitute negligence when disabling emotional sequelae ensue.<sup>3</sup>

Propofol (2,6-diisopropylphenol) is a novel iv anesthetic with pharmacologic properties that encompass many characteristics of an ideal iv anesthetic agent. Its rapid onset and dissipation of action, near absence of prolonged "hangover" effects, and ability to attenuate the cardiovascular response to laryngoscopy make it a logical candidate for use in TIVA-jet venturi ventilation techniques.<sup>2,†</sup> Use of opioids and/or nitrous oxide with propofol during TIVA is common and attempts to overcome propofol's lack of significant analgesic properties. One review suggests that absence of amnestic effects also may limit propofol's use as the sole agent in TIVA techniques.<sup>‡</sup> More recent preliminary data indicate that propofol does produce dose-dependent amnesia,<sup>11-14</sup> perhaps through enhancement of  $\gamma$ -aminobutyric acid-mediated inhibition in the brain.<sup>15,16</sup> Absence of a painful stimulus (spinal anesthesia,<sup>11</sup> word or picture recall in healthy volunteers<sup>13,14</sup>) or attenuation of the painful stimulus by simultaneously administered opioids,<sup>12</sup> however, makes extrapolation of this evidence to our case difficult.

Reports of patients undergoing TIVA with propofol and jet venturi ventilation are similarly confounded. DeGrood and colleagues<sup>17</sup> reported no awareness in 30 patients randomized to receive either propofol or etomidate TIVA with jet venturi ventilation for microlaryngeal surgery. One patient in the propofol group, however, did complain of bad dreams associated with the intraoperative period. All patients also received intermittent boluses of alfentanil and topical anesthesia of the larynx with 4% lidocaine.<sup>17</sup> A similar study of 14 patients by Mayné and associates reported no side effects, but their study design did not specifically attempt to elicit recall postoperatively.<sup>18</sup> Best and Traugott<sup>19</sup> reported a randomized single-blind crossover trial comparing propofol with methohexital in 20 patients receiving TIVA-jet venturi venti-

lation for recurrent microlaryngeal procedures. All patients received preanesthetic medication in addition to topical anesthesia of the larynx. Their results did not address the issue of intraoperative awareness, although one patient was disturbed by memory of recovery room events after receiving propofol.<sup>19</sup> Harries *et al.*<sup>20</sup> randomized 40 unpremedicated patients undergoing extracorporeal shock-wave lithotripsy using TIVA-jet venturi ventilation to receive either propofol or methohexital. All patients also received intermittent bolus fentanyl, topical laryngeal anesthesia, and 50% nitrous oxide. When directly questioned postoperatively, only one patient receiving methohexital TIVA had any intraoperative awareness.<sup>20</sup>

We reviewed anesthetic records from our patient's 17 microlaryngeal procedures to determine factors preventing recall during the other 16 anesthetics (table 1). Methohexital TIVA (used in 13 of these cases) was associated with concurrent midazolam administration as well as the use of fentanyl in all but one case. Lack of awareness during these methohexital anesthetics is thus not surprising. Despite extensive use of these adjunctive agents, antihypertensive therapy (nitroglycerin and/or  $\beta$  blockers) was required in every case using methohexital TIVA. In the 3 remaining cases of propofol TIVA, the range of induction doses and infusion rates were 160–200 mg and 35–200  $\mu\text{g} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ , respectively. Midazolam and/or fentanyl were administered in all three instances. Treatment for intraoperative hypertension was not required when fentanyl (with or without midazolam) was added to the propofol TIVA technique.

Our case was unique in that the patient received only propofol TIVA and jet venturi ventilation for his microlaryngeal procedure. No preanesthetic medication or adjunctive anesthetic agents were administered, in contrast to the patient's other anesthetic experiences and the cited propofol TIVA-jet venturi ventilation studies. It is possible that recall might not have occurred had we used the higher propofol induction dose (2.5  $\text{mg} \cdot \text{kg}^{-1}$ ) shown to

TABLE 1. Summary of Our Patient's 17 Anesthetics

Adjunctive Anesthetic Agents	Total Anesthetics (17)	
	Methohexital TIVA (13)	Propofol TIVA (4)
Fentanyl without midazolam	0	1
Midazolam without fentanyl	1	1
Fentanyl and midazolam	12	1
Droperidol	8	1
Lidocaine (iv, LTA)	5	1
Inhalation agent Pre/Post-JVV	4	1
Primary TIVA agent alone	0	1*
Antihypertensive agents	13	2

\* Intraoperative awareness.

TIVA = total intravenous anesthesia; iv = intravenous; LTA = laryngotracheal administration; JVJ = jet venturi ventilation.

be effective in 95% of unpremedicated patients.<sup>2</sup> This was somewhat mitigated, however, by our use of a constant-rate continuous propofol infusion, as opposed to the progressively decremental propofol infusion rates reported in other TIVA-jet venturi ventilation series.<sup>17,18,20</sup> Our patient's hypertension and tachycardia associated with laryngeal suspension could have suggested inadequate anesthetic depth. Autonomic signs, however, are unreliable indicators of awareness secondary to light anesthesia.<sup>4-6</sup> We chose to treat this episode with labetalol rather than more propofol in view of the patient's wishes for rapid recovery and early discharge.

In summary, we report a case of intraoperative recall during propofol TIVA and jet venturi ventilation for microlaryngeal surgery. Based on our experience, we have altered our technique to include a larger propofol induction dose combined with midazolam 30–40  $\mu\text{g} \cdot \text{kg}^{-1}$  iv and/or fentanyl 1–2  $\mu\text{g} \cdot \text{kg}^{-1}$  iv to deepen the level of anesthesia, provide analgesia, and take advantage of the known amnestic properties of benzodiazepines.<sup>3</sup>

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