Survey of anesthesiologists on anesthetic maintenance techniques and total intravenous anesthesia for endoscopic sinus surgery

Yuki Yoshiyasu, BS[1,2], Veronica F. Lao, MD[2], Samuel Schechtman, MD[3], Douglas A. Colquhoun, MB ChB, MSc, MPH[3], Sabrina Dhillon, MD[4] and Philip G. Chen, MD[1]

Background: **Inhalational anesthesia and total intravenous anesthesia (TIVA) are techniques used for maintenance of general anesthesia for endoscopic sinus surgery (ESS). Growing evidence exists that TIVA may be associated with decreased bleeding and improved surgical fields, yet data suggest it is used in a minority of sinus surgery cases. The objective of this study was to investigate perceptions and approaches to anesthetic maintenance techniques in ESS among anesthesia providers.**

Methods: **A total of 719 anesthesiology residents, faculty, and certified registered nurse anesthetists (CRNAs) at 3 tertiary academic centers in the United States were invited to participate in a survey of considerations and practice patterns for inhalational anesthesia and TIVA for ESS.**

Results: **Responses were received from 200 participants (28%). Sixty-five percent of respondents reported a lack of familiarity with current literature on TIVA for ESS. Many considered factors other than surgical field visualization when choosing a maintenance technique. Most were comfortable with performing TIVA but stated they would participate in additional training.**

Conclusion: **The majority of anesthesiology providers were unaware of the existing literature demonstrating advantage in improved surgical visualization with TIVA. Many used a combination of inhaled and intravenous anesthetics for maintenance. These findings suggest that future opportunities may exist to develop education, training, and practice approaches specific to anesthetic techniques for ESS.**

Key Words:
endoscopic sinus surgery; education; total intravenous anesthesia; TIVA; inhalational anesthesia

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Endoscopic sinus surgery (ESS) is commonly performed for various sinonasal pathologies with an estimated 250,000 cases performed annually in the United States.[1] The variability and complexity of the nasal sinuses combined with the close proximity of important anatomical structures such as the brain, orbit, and carotid arteries leads to risk of major complications including cerebrospinal fluid (CSF) leak, orbital injury, and hemorrhage.[2]

Significant intraoperative mucosal bleeding interferes with the surgical visual field and may increase risk of complications.[3,4] Interventions that may improve the surgical field by means of limiting bleeding include intranasal vasoconstrictor application and injection, preoperative

[1]*Department of Otolaryngology–Head and Neck Surgery, University of Texas Health Science Center San Antonio, San Antonio, TX;* [2]*Department of Anesthesiology, University of Texas Health Science Center San Antonio, San Antonio, TX;* [3]*Department of Anesthesiology, Michigan Medicine-University of Michigan Medical School, Ann Arbor, MI;* [4]*Department of Anesthesiology, Virginia Commonwealth University, Richmond, VA*

Correspondence to: Philip G. Chen, MD, University of Texas Health Science Center San Antonio, 7703 Floyd Curl Drive, MC 7777, San Antonio, TX 78229; e-mail: p_g_chen@hotmail.com

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steroids, topical decongestants, reverse Trendelenburg positioning, and controlled hypotension.[5,6]

Anesthetic technique may influence bleeding risk. Inhalational anesthesia—the maintenance of anesthesia via use of volatile anesthetics including most commonly sevoflurane, isoflurane, desflurane, and/or nitrous oxide—is associated with decreased peripheral vascular resistance, which may increase bleeding in the nasal mucosa during ESS.[7] An alternative technique is total intravenous anesthesia (TIVA) where anesthetic drugs, most commonly propofol and remifentanil, are administered intravenously and may decrease nasal bleeding by limiting peripheral vasodilation in the nasal mucosa.[8] Prior investigation has suggested that TIVA for ESS can improve surgical field visualization and bleeding compared to inhalational anesthesia.[4,7,9] An additional advantage of TIVA is the reduced incidence of postoperative nausea and vomiting (PONV), which may in turn decrease the risk of postoperative epistaxis.[10,11] Despite these advantages, existing data suggest TIVA is used for as low as 7% of ESS cases in some locations.[12]

Although studies have investigated patient outcomes between inhalational and intravenous techniques, there is limited information regarding clinician factors in decision-making that affect anesthetic maintenance approach for ESS. Therefore, we aimed to provide unique insights into current ESS anesthetic practices and education via online questionnaire of anesthesiology residents, faculty, and certified registered nurse anesthetists (CRNAs). We hypothesized that many anesthesiology providers are not aware of literature supporting possible improved surgical conditions with TIVA for ESS. Additionally, we hypothesized that many anesthesiology providers do not provide care for ESS cases frequently, and may consider other factors greater than the surgical field in choice of maintenance technique.

Materials and methods

Institutional Review Board (IRB) exemption was obtained from the University of Texas Health Science Center San Antonio (IRB HSC20180291E), University of Michigan (IRB HUM00150344), and Virginia Commonwealth University (IRB HM20014737). An electronic questionnaire (Supporting Fig. 1) was developed by the research team. The initial draft was piloted on a focus group composed of 5 anesthesiologists. Feedback was sought and the questionnaire was further revised.

The following demographic parameters were collected: training level, fellowship training in head and neck anesthesia, number of ESS cases managed per month. Participants were asked to provide their understanding of current medical literature regarding use of TIVA for ESS. This survey inquired about practice patterns for anesthetic techniques in ESS, including methods to ensure unconsciousness and which specific anesthetic agents are used. Participants' satisfaction with their training specific to ESS was assessed. Additionally, anesthesiology faculty were asked their perceived level of comfort with residents and CRNAs performing TIVA for ESS.

The survey tool was distributed via email to 719 participants comprising of 179 anesthesiology residents, 272 faculty, and 268 CRNAs at multiple training programs between February 2019 and April 2019. There was no incentive to participate in this survey. Individuals were able to decline to participate in the survey or withdraw at any time. Surveys were administered in electronic format via REDCap electronic data capture tools hosted at the University of Texas Health Science Center San Antonio and responses were automatically recorded in a secure electronic database without identifying information.[13]

Results

A total of 266 anesthesia providers responded to the survey. Sixty-six responses were excluded based on incompleteness and/or early termination of the survey. A total of 200 responses (28%) were included in the final analysis, comprising 51 residents, 2 fellows, 79 CRNAs, and 68 faculty members.

Table 1 describes the demographics of the survey population. 90% of anesthesia providers managed fewer than 5 ESS cases per month. Sixty-five percent of participants responded that they were not familiar with current literature and investigational findings on TIVA for ESS. When asked to provide a general anesthetic for a patient undergoing ESS with no relevant comorbidities, 81 (40%) participants selected an inhalational anesthetic approach and 119 (60%) chose TIVA.

When asked about ESS-specific anesthesia training, most participants (73%) had received instruction via direct supervision of attending physicians in the operating room, whereas few had received in-person lectures or online courses (19 and 11 respondents, respectively).

Residents, attending physicians, and CRNAs were satisfied with their training for inhalational anesthetic management for ESS 56% and TIVA approach for ESS (57%). Most residents stated that they were comfortable or very comfortable with using inhalational anesthesia (74%) or TIVA (79%) for ESS. However, residents (51%) and CRNAs (75%) responded that they would participate in additional training opportunities.

Thirty-one (80%) anesthesiology attending physicians responded that they were neutral or comfortable with first-year clinical anesthesia (CA-1) residents performing TIVA for ESS. As expected, the level of comfort increased as experience increased, with 64 (94%) attending physicians being comfortable or very comfortable with third-year clinical anesthesia (CA-3) residents performing TIVA for ESS.

Figure 1 details the rankings of specific considerations when using TIVA for ESS. Postoperative nausea, intraoperative hemodynamics, and gentle emergence were the top 3 considerations for using TIVA. Least important considerations were cost of anesthetic agents and surgical field visibility.

TABLE 1. Demographics of survey respondents

Characteristic	Resident	CRNA	Faculty	
			Non-H&N	H&N
Total surveyed (n)	179	268	272	
Total number of respondents (n)	53	79	56	12
Year in residency (n)				
CA-1	19	–	–	–
CA-2	19	–	–	–
CA-3	13	–	–	–
Fellow	2	–	–	–
How many years have you been practicing medicine? years (95% CI)		11.29 (9.72–13.88)	11.04 (8.53–13.55)	
On average, how many ESS cases do you manage per month? n (%)				
0–5 cases	52 (98)	69 (87)	54 (96)	4 (33)
5–10 cases	1 (2)	9 (11)	2 (4)	4 (33)
>10 cases	0 (0)	1 (1)	0 (0)	4 (33)
Out of these ESS cases, what percentage of cases do you use TIVA? n (%)				
<50%	16 (30)	33 (42)	28 (50)	0 (0)
50%–75%	10 (19)	11 (14)	7 (13)	0 (0)
75%–90%	6 (11)	4 (5)	4 (7)	2 (17)
>90%	21 (40)	31 (39)	17 (30)	10 (83)
How would you rate the strength of evidence in the use of TIVA in ESS? n (%)				
Not familiar with current literature	34 (64)	58 (73)	33 (59)	5 (42)
No articles support TIVA use in ESS	1 (2)	0 (0)	0 (0)	0 (0)
Few articles support TIVA use in ESS	8 (15)	11 (14)	15 (27)	5 (42)
Many articles support TIVA use in ESS	10 (19)	10 (13)	8 (14)	2 (17)

CA = clinical anesthesia; CI = confidence interval; ESS = endoscopic sinus surgery; H&N = specialize in head and neck anesthesiology; TIVA = total intravenous anesthesia.

Anesthesia practice patterns for TIVA are detailed in Table 2.

Discussion

Previous comparative studies of inhalational anesthesia and TIVA techniques for ESS have primarily focused on outcomes of ESS such as blood loss and cardiovascular parameters, rather than the factors that influence decision making to the choice of anesthetic.[7,9,14] This survey is the first to investigate the opinions of anesthesia providers at various levels of training and geographic locations on inhalational anesthesia and TIVA for ESS with regard to practice patterns, recognition of clinical evidence, procedural comfort, and training satisfaction. We found that many providers (1) do not routinely manage high volumes of ESS cases, (2) are unfamiliar with TIVA literature for ESS, and (3) are open to further learning.

In this study, 65% of survey respondents stated that they were not very familiar with the current literature on TIVA for ESS. Thus, trainees might benefit from further education specific to ESS. Many trainees were comfortable with performing anesthesia for ESS, but were willing to participate in additional training opportunities to learn techniques that can benefit both surgeon and patient.

The most common method of TIVA training was the traditional model of apprenticeship, where residents will begin by assisting attending physicians and gradually build the skills and experience necessary for independent practice. However, this modality can be limited by low ESS case volumes. For 98% of residents and 96% of non–head and neck fellowship-trained faculty, ESS is not a part of their routine weekly clinical practice because they are managing fewer than 5 ESS cases a month. Thus, opportunities for direct supervision in the operating room may be hampered by the low numbers of ESS cases.

TIVA is used for many operations other than ESS for a variety of reasons.[15] This study suggests that the anesthesiologists' main considerations for choosing when to use TIVA are patient factors such as maintaining hemodynamics

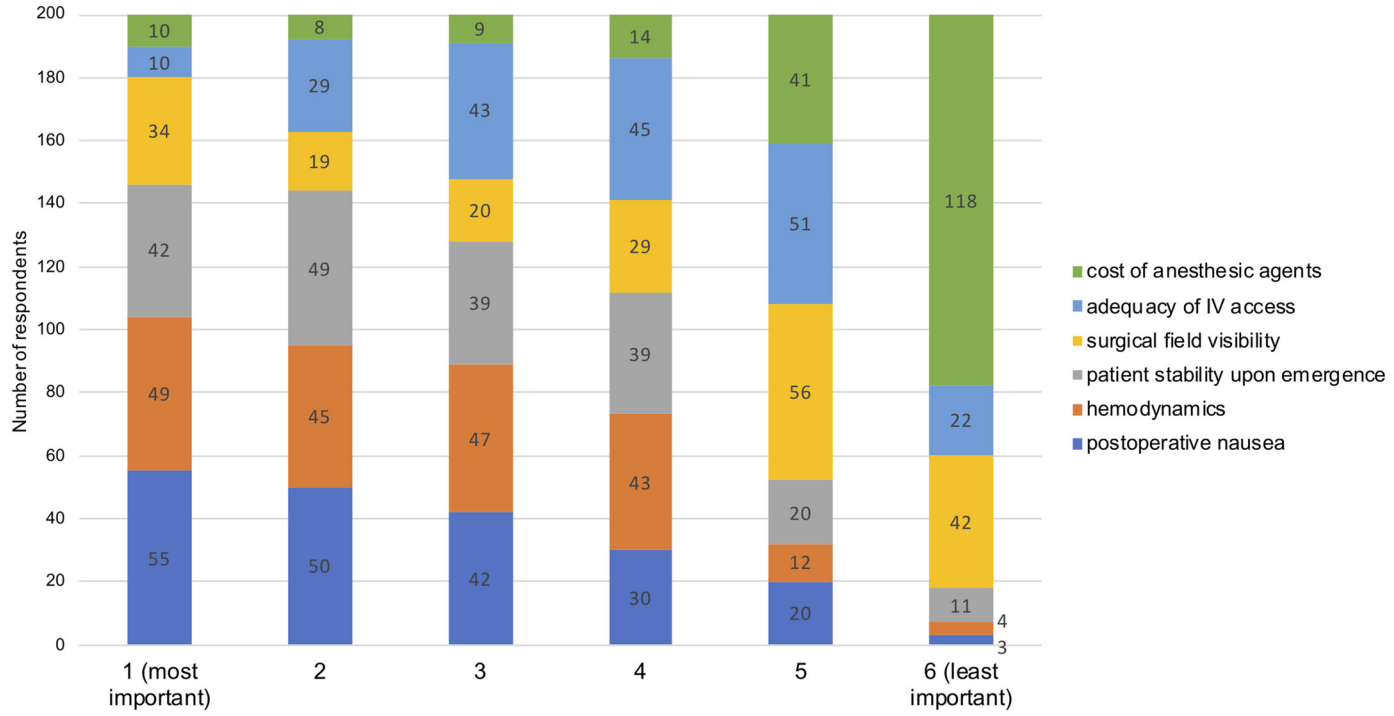

FIGURE 1. Ranking of considerations for use of TIVA in ESS. ESS = endoscopic sinus surgery; TIVA = total intravenous anesthesia.

TABLE 2. Anesthesia practice patterns for TIVA

Question	Resident n (%)	Faculty n (%)	CRNA n (%)
When performing general anesthesia using TIVA, which of the following do you commonly use to ensure unconsciousness? Select all that apply			
Bispectral index monitor	20 (37.7)	23 (33.8)	17 (21.5)
Minimum alveolar concentration values	27 (50.9)	23 (33.8)	33 (41.8)
Hemodynamics	27 (50.9)	38 (55.9)	48 (60.8)
Inhalational agent	47 (69.1)	40 (75.5)	48 (60.8)
Desflurane	7 (13.2)	3 (4.4)	2 (2.5)
Sevoflurane	21 (39.6)	21 (30.9)	25 (31.6)
Isoflurane	20 (37.7)	8 (11.8)	12 (15.2)
Nitrous oxide	18 (34.0)	25 (36.8)	26 (32.9)
Which of the following agents do you most commonly use for maintenance of TIVA? Select all that apply			
Propofol	53 (100.0)	68 (100.0)	79 (100.0)
Remifentanil	53 (100.0)	63 (92.6)	70 (88.6)
Fentanyl	1 (1.9)	9 (13.2)	16 (20.3)
Dexmedetomidine	14 (26.4)	13 (19.1)	19 (24.1)
Lidocaine	8 (15.1)	10 (14.7)	8 (10.1)
Ketamine	12 (22.6)	12 (17.6)	21 (26.6)
Sufentanil	16 (30.2)	5 (7.4)	11 (13.9)
Alfentanil	1 (1.9)	0 (0.0)	0 (0.0)

CRNA = certified registered nurse anesthetist; ESS = endoscopic sinus surgery; TIVA = total intravenous anesthesia.

and controlling postoperative nausea. These factors are clearly important in patient care. However, our findings suggest anesthesia providers are often less focused on the surgical field during ESS, and therefore the surgeons should engage their colleagues in an informed dialogue regarding the desire and reasoning for TIVA in ESS. Unlike the 7% rate reported by Suhitharan et al.,[12] approximately 60% of those surveyed at 3 large medical centers default to the use of TIVA in ESS. The relatively lesser consideration of surgical visualization suggests an opportunity to translate the findings of the existing literature into routine practice, paralleling previous studies that show a lack of awareness and familiarity as barriers to guideline adherence.[16]

In terms of TIVA practices, this study showed that propofol and remifentanil were the most commonly used maintenance agents. The pharmacokinetic and pharmacodynamics properties of propofol and newer short-acting opioids have been well-studied and routinely used for TIVA. Unlike inhalational anesthesia where exhaled volatile anesthetics can be measured, there are no available methods to measure serum drug concentrations in TIVA to ensure intraoperative amnesia.[17] Thus, there is a potential role for additional monitoring such as bispectral index monitors if the anesthesia provider believes it is warranted, which one-third of respondents use.[18] Although not strictly TIVA, 68% of respondents added a small amount of inhalational gas to TIVA to ensure unconsciousness. Other efforts to address the challenges of titrating TIVA include target controlled infusion (TCI) systems. These devices automate TIVA delivery by calculation of an ideal drug infusion profile based on a patient's profile and target drug concentration.[19] Although TCI systems are well-established in Europe, it currently has not received regulatory approval in the United States and is only used in research.[19,20]

There are several limitations of this study. First, although the survey response rate (28%) is somewhat low, it is comparable to other similar studies that used web-based survey distribution methods.[21] Further, the total number of respondents (200) from multiple levels of experience augments the generalizability of these findings. As individuals are more apt to respond to survey on topics that are important or of interest to them, it is possible that survey participants have greater ESS experience compared to nonrespondents.[22] Second, participants were recruited from selected academic medical centers and may not generalize to other settings. However, disparate geographic locations were chosen to ensure a broad range of practice patterns and backgrounds. Per the results of the questionnaire, the majority of TIVA training for ESS was conducted via faculty supervision in the operating room. Thus, anesthetic practice may vary based on resident education programs. Third, two-thirds of the respondents stated that they add inhalational agent to TIVA for maintenance, which is not described in the literature strictly comparing inhalational anesthesia and TIVA. Nevertheless, our findings support the need for ongoing education specific to ESS anesthesia and for effective communication between surgeons and their anesthesiologist colleagues regarding anesthetic preferences.

Conclusion

Many anesthesiology providers in this unique survey of diverse training backgrounds were not aware of the literature regarding the benefits of TIVA in ESS for surgical visualization. TIVA is regularly performed for reasons other than ESS, but in the case of ESS, anesthesiologists in this survey frequently report reasons other than surgical field when considering TIVA. Surgeons should be well versed in the literature regarding TIVA and goals for their specific operation in order to engage in constructive conversations with their anesthesiology colleagues.

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