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Total Intravenous versus Inhaled Anesthesia in Transsphenoidal Tumor Surgery

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Abstract

Purpose: Visualization of the surgical field is essential for patient safety during endoscopic transsphenoidal tumor surgery. In this retrospective chart review and data analysis of patients undergoing endoscopic transsphenoidal resection of pituitary tumors under general anesthesia we sought to determine if total intravenous anesthesia with propofol and remifentanyl leads to decreased bleeding, surgical duration, time to extubation and/or length of stay in the recovery room compared to inhaled anesthesia with sevoflurane or desflurane.

Methods: After IRB approval, chart reviews of 193 American Society of Anesthesiologists class 1 to 3 patients were conducted who had undergone transsphenoidal, endonasal resections of pituitary tumors under total intravenous or inhaled anesthesia at an academic teaching hospital in the United States over a seven-year time period. One hundred four patients fulfilled the inclusion criteria and were further reviewed. Primary outcome was intraoperative blood loss; secondary outcomes were surgical duration, time to extubation and length of stay in the recovery room.

Results: Gender, age, and Lund-Mackay-Scores were equally distributed between the two anesthetic groups. We found no significant effect of the anesthetic technique, age, gender, or Lund Mackay score on any of the primary or secondary outcomes. The only significant predictor for recovery room length of stay was intraoperative blood loss.

Conclusion: Our study shows no evidence that total intravenous anesthesia is superior to inhaled anesthesia or vice versa during endoscopic transsphenoidal sinus surgery with regards to relevant clinical outcome parameters.

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Keywords

TIVA; volatile anesthetics; blood loss; propofol; sinus surgery

1. Introduction

Tumors of the pituitary gland are quite common and comprise about 10% of diagnosed brain neoplasms.¹ Their transsphenoidal resection may represent as much as 20% of intracranial operative procedures. Pituitary disease provides the anesthesiologist with a multitude of unique challenges;^{1–4} among those is the maintenance intraoperative hemodynamic stability to decrease bleeding and facilitate optimal surgical field visualization.⁵ The latter is critical to reduce complications in any form of endoscopic sinus surgery.^{6,7}

Various methods and medications to produce a bloodless field have been investigated.^{8–11} Although different anesthetic drugs can differentially affect hemodynamics and potentially decrease local bleeding, it is still a matter of intense debate if total intravenous anesthesia (TIVA) is indeed superior to inhaled anesthesia (InhA).^{12–17}

In this retrospective, single center study, we tested if TIVA with propofol and remifentanyl had a positive impact on estimated blood loss (EBL) and other clinically relevant secondary outcomes during and after transsphenoidal pituitary tumor surgery compared to InhA.

2. Methods

A power analysis based on Chowdhury et al.¹⁸ revealed a sample size of 45 patients per group to find a clinically relevant decrease in EBL of 25% with a power of 80%. After approval by the Institutional Review Board of the Medical College of Wisconsin (MCW), we conducted a retrospective chart analysis of 193 American Society of Anesthesiologists (ASA) class 1 to 3 patients who had undergone transsphenoidal, endonasal resections of pituitary tumors at MCW over a seven-year time period. One hundred four patient records matched the study's inclusion criteria: 18–80 years of age; no prior history of sinus surgery; general anesthesia with TIVA or InhA. Eighty nine patients were excluded from the study for non-pituitary surgery / CSF leak repair (n = 12); significant sinus morbidity by Lund Mackay (LM) scoring system (n = 5), general anesthesia with combined TIVA and InhA (n = 72).

The type of anesthesia was chosen by the attending anesthesiologist for each case and was not controlled by the study. All patients were monitored with standard ASA monitoring: electrocardiogram, non-invasive blood pressure, pulse oximeter, concentration of inhaled O₂ and end-tidal CO₂, and temperature. As per institutional standard, general anesthesia was induced with propofol (1–2 mg/kg), lidocaine (1 mg/kg), fentanyl (2 mcg/kg). After loss of consciousness, confirmed by eyelash reflex and adequate mask ventilation, rocuronium (0.6 mg/kg) was given for tracheal intubation, and patients were ventilated with an air-O₂ mixture (2:1). In the TIVA group, a remifentanyl infusion (0.1 mcg/kg/min) and a propofol infusion (100 mcg/kg/min) were initiated; propofol was adjusted according to hemodynamic changes. In the InhA group, general anesthesia was maintained with sevoflurane (0.5–2%) or

desflurane (6–10%) and fentanyl boluses as required. Rocuronium was given as required for neuromuscular blockade (NMB). EBL was assessed with the amount of blood in the suction canister minus any irrigation used. 15 minutes before the end of surgery, propofol was discontinued, and the rate of remifentanyl was reduced to 0.02 mcg/kg/min in the TIVA group; in the InhA group, the end-tidal inhaled anesthetic concentration was reduced. Hydromorphone 0.4–0.6 mg was given in both groups before emergence. NMB reversal was achieved with neostigmine (0.02–0.04 mg/kg) and glycopyrrolate (0.004–0.006 mg/kg). Patients were extubated when they met extubation criteria: widely awake, following commands, adequate tidal volume on spontaneous ventilation and adequate reversal of NMB. Patients were then taken to the recovery room with O₂ delivered via face mask.

Statistics: Categorical data were calculated as percentages, parametric data as mean $\pm$ standard error. Anesthetic groups were compared by Chi-Square tests and two-tailed, unpaired student t-tests, respectively. Multiple regression and correlation analyses were used to test for possible associations among different variables. Differences were considered statistically significant when $P < 0.05$ (two-tailed). Independent parameters included patient demographics such as gender, age, LM score (determined by an ENT surgeon and blinded member of our team), and type of anesthesia (TIVA vs InhA). Dependent variables included the primary outcomes of total EBL and EBL rate during surgery (total EBL divided by duration of surgery), and the secondary outcomes of surgical duration, time from end of surgery to extubation, and length of stay (LOS) in the recovery room.

3. Results

Table 1 shows the patient's demographics separated by type of anesthesia; there were no significant differences in age, gender, or LM scores between the two anesthetic groups. The type of anesthesia did not affect primary or secondary outcomes, namely total EBL, EBL rate, surgical duration, time to extubation, or recovery room LOS (table 2). Total EBL correlated significantly with surgical duration, but not gender, age or LM score. Conversely, recovery room LOS correlated significantly with total EBL and EBL rate, but no other factors.

4. Discussion

Endoscopic transsphenoidal surgery is challenging due to a constricted nasal passage and highly vascular tissue.⁴ Endoscopic guidance along with pre-operative three-dimensional imaging and computer-assisted navigation has improved surgical outcomes.^{19,20} Maintenance of hemostasis is essential for adequate surgical visualization and working space, and in turn reduces complications. Various types of anesthetic techniques have been tried for general anesthesia in patients undergoing an endoscopic approach for transsphenoidal resection of pituitary tumors in order to reduce surgical bleeding, duration of surgery and side effects, such as less nausea, faster wake-up, less need for revisions, etc.^{4,16}

The use of TIVA vs InhA has been studied extensively in conventional endoscopic sinus surgery, but, so far, with inconclusive outcomes.^{15,17,21} Although several studies have

concluded that TIVA may improve surgical conditions during the endoscopic sinus surgery,^{12,13,22–24} others could not show a difference,^{25,26–28} and more so, those that did, often had severe limitations in design and/or power to preclude an overall recommendation.^{10,14,15} Caution is also warranted because different agents are used in TIVA at different combinations and infusion rates; the same is true for different InhA regimen. Moreover, studies are rarely controlled for the effect of the anesthetic regimen on blood pressure or its determinants cardiac output and systemic vascular resistance.^{29–31} Other factors, such as nasal polyposis, degree of inflammatory disease, positioning of the patient, irrigation, topical decongestion, and injection of vasoconstrictors, that may play an important role for blood loss, may not have been strictly controlled in these studies, either.¹⁵

The level of evidence for endoscopic transsphenoidal surgery is even scarcer. Though TIVA was found feasible and safe,^{32,33} there was no evidence of decreased blood loss, only a slightly faster wakeup with sevoflurane vs propofol when remifentanyl was used in both groups.³⁴ Other studies found no difference in wake-up between sevoflurane and propofol, but did not assess³⁵ or found no difference in blood loss between the groups.¹⁸ There was also no difference in the severity of stress response during pituitary surgery between TIVA and sevoflurane/N₂O inhaled anesthesia.³⁶ Consequently, pertinent review articles on perioperative management of patients undergoing endoscopic transsphenoidal surgery do not recommend one particular anesthetic technique over another,^{1–4} as long as a reasonably rapid recovery for timely postoperative neurological assessment is facilitated^{3,4} for which shorter acting volatile anesthetics or propofol appear to have an advantage over isoflurane.³⁵

In line with these findings, our study did not detect a difference in total EBL or EBL rate, surgical duration, time to extubation, or recovery room LOS between TIVA and InhA; unrelated to the anesthetic technique, only the recovery room LOS correlated positively with EBL. Naturally, our study needs to be seen within the constraints of the expected limitations of a retrospective analysis at a single center whose results may not necessarily be transferred to other patient populations or conditions. Although limited in its number of studied patients and the possibility of a type II error, a post-hoc sample size analysis based on our EBL findings would necessitate the study of more than 2,200 patients to demonstrate statistical significance of the observed overall EBL decrease of 9.3 cc with a power of 80%; this appears neither feasible nor would it be clinically relevant.

5. Conclusion

Our study adds to the contention that TIVA is not superior to InhA and that the increased costs associated with TIVA do not benefit the patient with regards to the tested primary or secondary outcomes EBL, extubation time or recovery room LOS. Conversely, even a larger scale study may only show minimal decrease in bleeding without clinical significance.

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Table 1

Patients' Demographics

	InhA (n = 50)	TIVA (n = 54)	P-Value
Age (years)	51 ± 3	55 ± 2	0.33
Female Gender (n [%])	24 [48]	28 [52]	0.84
Lund-McKay Score	2.7 ± 0.4	2.6 ± 0.4	0.88

All data are mean ± standard error, unless otherwise indicated. InhA = inhaled anesthesia; TIVA = total intravenous anesthesia.

Table 2

Primary and Secondary Outcomes

	InhA (n = 50)	TIVA (n = 54)	P-Value
Total EBL (ml)	87 ± 12	77 ± 9	0.50
EBL Rate (ml/min)	0.65 ± 0.07	0.58 ± 0.06	0.45
Duration of Surgery (min)	126 ± 7	133 ± 6	0.41
Time to Extubation (min)	14 ± 1	15 ± 1	0.46
Recovery Room LOS (min)	61 ± 2	63 ± 4	0.62

All data are mean ± standard error. InhA = inhaled anesthesia; TIVA = total intravenous anesthesia; EBL = estimated blood loss; LOS = length of stay.