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Effects of general anesthesia on quality of recovery after transaxillary endoscopic breast augmentation

A randomized controlled trial

Chih-Cheng Hung, MD[a,b], Kuo-Cherh Huang, PH[a,*]

Abstract

Background: Types of general anesthesia may affect the quality of recovery, but few studies have investigated the quality of postoperative recovery, and none has focused on patients undergoing breast augmentation.

Methods: This prospective, parallel, randomized controlled study enrolled 104 patients undergoing transaxillary endoscopic breast augmentation. Eligible patients were randomly assigned to receive inhalation anesthesia (IH, n = 52) or total intravenous anesthesia (TIVA, n = 52). Quality of recovery was assessed on the first and on the second postoperative days using the 15-item Quality of Recovery questionnaire (QoR-15). Baseline demographic, clinical characteristics, and operative data were also collected.

Results: The IH and TIVA groups had similar QoR-15 total scores on the first postoperative day ($P = .921$) and on the second postoperative day ($P = .960$), but the IH group had a significantly higher proportion of patients receiving antiemetics than the TIVA group (53.6% vs 23.1%, $P = .002$). Multivariate analysis revealed that the type of general anesthesia was not significantly associated with QoR-15 total scores on the first postoperative day ($\beta = 0.68$, $P = .874$) and with QoR-15 total scores on the second postoperative day ($\beta = 0.56$, $P = .892$), after adjusting for age, BMI, operation time, steroids use, and antiemetics use.

Conclusion: For the patients undergoing transaxillary endoscopic breast augmentation, the type of general anesthesia did not significantly impact the quality of recovery. Both IH or TIVA could provide good quality of recovery demonstrated by high QoR-15 total scores. The results suggested that the type of general anesthesia may not be the most critical factors of quality of recovery in the patients undergoing transaxillary endoscopic breast augmentation.

Abbreviations: ASA = American Society of Anesthesiologists, BIS = bispectral index, BMI = body mass index, IH = inhalation anesthesia, PONV = postoperative nausea and vomiting, QoR-15 = 15-item Quality of Recovery Score, SD = standard deviation, TIVA = total intravenous anesthesia.

Keywords: breast augmentation, inhalation anesthesia, quality of recovery, total intravenous anesthesia

1. Introduction

Breast augmentation is one of the most frequently performed cosmetic surgeries.[1] Breast augmentation must be performed under general anesthesia accompanied by its effects and potential complications. Currently, the 2 most common techniques of general anesthesia are inhalation anesthesia (IH) using a range of inhaled agents and total intravenous anesthesia (TIVA) such as propofol. The effects of these types of general anesthesia on the quality of recovery have been investigated for numerous surgical procedures, including inpatient and outpatient elective surgeries,[2] laparoscopic cholecystectomy,[3] thyroid surgery,[4] laparoscopic sleeve gastrectomy,[5] transabdominal robotic-assisted laparoscopic surgery,[6] gynecologic surgery,[7] elective craniotomy,[8] and elective breast surgery for cancer.[9] Results of a randomized controlled trial including 2010 patients undergoing elective surgery revealed that TIVA significantly reduced the risk of postoperative nausea and vomiting compared with IH.[2] A randomized controlled trial including female patients undergoing thyroid surgery reported that TIVA group had significantly better quality of recovery than IH group.[4] TIVA was also reported to be associated with shorter recovery time[3] and less pain[5] than IH after surgery. Apparently, TIVA and IH may bring different physical impacts in postoperative period. However, there were

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The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

[a] *School of Health Care Administration, Taipei Medical University, Taipei, Taiwan,* [b] *Chimay Plastic Surgery Clinic, Taipei, Taiwan.*

[*] *Correspondence: Kuo-Cherh Huang, School of Health Care Administration, Taipei Medical University, No. 250, Wuxing Street, Sinyi District, Taipei 11031, Taiwan (e-mail: kchuang@tmu.edu.tw).*

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very few studies on the effect of TIVA versus IH on postoperative recovery for breast augmentation surgery.

Breast augmentation has a certain uniqueness because it is an office-based outpatient procedure and is typically performed for aesthetic or cosmetic reasons rather than for a medical necessity. Thus, postoperative recovery is a critical factor and quality and safety must be assured, and the quality of care demanded appears to be even higher than that for medical surgeries.[10–12] While the endoscopic transaxillary approach has become the preferred incision for Asian women due to their tendency of hyperpigmentation and scar formation after skin injuries,[13–16] the effect of general anesthesia on quality of recovery deserves more attention for patients undergoing transaxillary endoscopic breast augmentation

We hypothesized that different types of anesthesia may be associated with the quality of recovery among patients receiving breast augmentation procedures. Therefore, the purpose of this study was to evaluate the effects of IH versus TIVA on the quality of recovery in patients undergoing transaxillary endoscopic breast augmentation. Results of this study can remind surgeons of the importance of quality of recovery and may be helpful to surgeons and anesthesiologists in choosing the most appropriate type of general anesthesia for breast augmentation surgeries.

2. Methods

2.1. Design and ethical considerations

A prospective, parallel, randomized controlled study was conducted at Chimay Plastic Surgery Clinic between July 2017 and May 2018. The study protocol was reviewed and approved by the Institutional Review Board at Taipei Medical University (TMU-JIRB No.: N201705057). All included patients provided signed informed consent to participate in the study. The study has been registered in ClinicalTrial.gov (NCT04036487).

2.2. Study subjects

At the Chimay Plastic Surgery Clinic, patients who were scheduled for breast augmentation procedures were screened for study eligibility by 1 qualified plastic surgeon who had been board-certified for more than 20 years. The inclusion criteria were: patients undergoing transaxillary endoscopic breast augmentation; age between 20 and 65 years; and classified as Physical Status I or II as defined by the American Society of Anesthesiologists (ASA) Physical Status Classification System.[17] Exclusion criteria were: having difficulty reading or hearing; diagnosed with addictive disorder; diagnosed with psychiatric disorder; Physical Status III–VI as defined by the ASA Physical Status Classification System; and presence of acute infection or inflammatory condition (e.g., fever). Patients who met these criteria were then enrolled. After enrollment, the patients were randomly assigned to an IH group or a TIVA group according to a random table. Patients were not aware of the results of randomization. The surgeon and the anesthesiologist were not blinded to patient selection.

2.3. Procedures

All transaxillary endoscopic breast augmentation was performed under general anesthesia by the plastic surgeon. The surgery was performed as a routine procedure, following the method employed by Sim et al.[18] Study subjects received no medications before surgery. Routine monitoring was applied, including pulse oximetry (SpO2), electrocardiogram, noninvasive arterial pressure, nasopharyngeal temperature, concentration of end-tidal CO2, and measurement of the bispectral index (BIS). All patients received standardized anesthesia induction by sequential boluses of intravenous remifentanil (0.5–1 μg/kg), and propofol (2–3 mg/kg). Rocuronium (0.6 mg/kg) was given after loss of the eyelash reflex and the trachea was intubated. Mechanical ventilation was provided with a tidal volume of 8 mL/kg. Concentration of end-tidal CO_2 was maintained at 4.6 to 5.3 kPa with an air/oxygen mixture (fraction of inspired oxygen 0.5) by adjusting ventilator frequency. In the TIVA group, anesthesia was maintained by propofol at a continuous infusion rate of 2 to 8 mg/kg/h. In the IH group, anesthesia was maintained by 1.0% to 2.5% isoflurane. Both groups also received continuous infusion of remifentanil at a dose of 0.05 to 2 μg/kg/min. Throughout the procedure, body temperature was maintained at 36 to 37°C and arterial pressure was maintained within 20% of preinduction level in all patients. The depth of anesthesia was monitored by BIS score and anesthesia was titrated to obtain a BIS score of 40 to 60 in both groups. If there were signs of inadequate anesthetic depth (e.g., sweating, swallowing, movement, tachycardia, or elevated arterial pressure >20% of preinduction level), the rate of propofol infusion or the end-expiratory concentration of isoflurane was increased. If this was not sufficient, bolus remifentanil (0.5 μg/kg) was given.

After recovery from anesthesia, all patients were administered intravenously of ketorolac 30 mg. No prophylactic antiemetics were given perioperatively or postoperatively. Postoperative nausea and vomiting (PONV) were evaluated using a 10-point numeric rating score (0 = none, 10 = unbearable). If PONV occurred or the rating score exceeded 5, antiemetics (dimenhydrinate 1 mg/kg) or corticosteroids (dexamethasone 0.1 mg/kg) were given intravenously.

2.4. Outcome measures

The main outcome measure was quality of recovery, gauged according to scores of the 15-item Quality of Recovery (QoR-15) questionnaire.[12,19] Patients were asked to fill out the questionnaire twice, each on the first postoperative day and on the second postoperative day. The QoR-15 questionnaire includes 2 domains with a total of 15 items.[12,19] Items are scored from 0 (poor) to 10 (excellent). A higher result indicates better quality of recovery; a score of 150 is a maximum score.[12,19] Patients' baseline demographic data, body mass index (BMI), and operative data were also collected. Operative data included operation time, use of steroids, and use of antiemetics.

2.5. Sample size calculation

This study included 1 independent variable (type of general anesthesia: IH vs IV) and 6 control variables (age, sex, BMI, operation time, use of steroids, use of antiemetics). Under the setting of a type I error of 5%, statistical power of 80%, 2-tailed tests, and medium effect size as defined by Cohen,[20] the number of samples required for this study was 103. Therefore, 52 patients were required for each group receiving a different type of general anesthesia.

Table 1

Comparisons of patients' demographic and clinical characteristics by type of general anesthesia.

Variables	IH	TIVA	*P*
Number	52	52	
Age (yr)	31.8 (5.9)	31.1 (6.1)	.501
Sex*			Not available
Female	52 (100.0)	52 (100.0)	
Male	0 (0)	0 (0)	
Body mass index (kg/m^2)	18.8 (1.5)	19.1 (2.6)	.599
Operation time (min)	295.2 (51.7)	287.1 (64.1)	.480
Use of steroids*			.842
Yes	30 (57.7)	32 (61.5)	
No	22 (42.3)	20 (38.5)	
Use of antiemetics*			.002†
Yes	28 (53.6)	12 (23.1)	
No	24 (46.2)	40 (76.9)	

IH = inhalation anesthesia, TIVA = total intravenous anesthesia.
* Data are presented as mean (standard deviation) or count (percentage).
† $P < .05$.

2.6. Statistical analysis

Data are expressed as mean (standard deviation [SD]) for continuous variables and as count (percentage) for categorical variables. Comparisons of demographics, operative data, and QoR-15 scores between the IH and TIVA groups were made using the 2-sample *t* test for continuous variables and Chi-square tests for categorical variables. Multivariable linear regression analysis was used to investigate the independent relationships between the type of general anesthesia and QoR-15 total scores on the first and second postoperative days, respectively. All statistical analyses were performed using SPSS software Version 22 (IBM Corp, Armonk, NY). A *P* value of $< .05$ was considered statistically significant.

3. Results

This study enrolled a total of 104 patients who were assigned randomly into 2 groups, each including 52 patients scheduled to undergo transaxillary endoscopic breast augmentation using either IH or TIVA general anesthesia. During the entire study period, no patient dropped out and none had missing data. Table 1 presents the comparison of baseline demographic and clinical data between the IH and TIVA groups. No significant differences were found between the 2 groups, except that the IH group had a significantly higher proportion of patients receiving antiemetics (53.6% vs 23.1%, $P = .002$) (Table 1). No patients required additional bolus remifentanil.

The IH and TIVA groups had similar QoR-15 total scores on the first postoperative day (118.9 vs 118.5, $P = .921$) and on the second postoperative day (123.8 vs 123.0, $P = .960$). No significant differences were found between the 2 groups regarding the score of each item on the first and second postoperative days (Table 2).

Table 3 presented the results of multivariate analysis of factors associated with QoR-15 total scores. After adjusting for age, BMI, operation time, use of steroids, and use of antiemetics, the type of general anesthesia was not significantly associated with QoR-15 total scores on the first postoperative day ($\beta = 0.68$, 95% CI = −7.84 to 9.81, $P = .874$) and with QoR-15 total scores on the second postoperative day ($\beta = 0.56$, 95% CI = −7.583 to 8.698, $P = .892$). No significant associations were found between age, use of steroids, use of antiemetics, and QoR-15 total scores. Notably, BMI was significantly and independently associated with QoR-15 total scores on the first postoperative day ($\beta = 2.14$, 95% CI = 0.18–4.11, $P = .033$) and with QoR-15 total scores on the second postoperative day ($\beta = 1.97$, 95% CI = 0.092–3.842, $P = .040$) (Table 3).

4. Discussion

This prospective, randomized, controlled study evaluated the quality of recovery using QoR-15 in patients undergoing transaxillary endoscopic breast augmentation and analyzed the relationship between quality of recovery and the type of general anesthesia. The results revealed that quality of recovery on the first and second postoperative days were both not associated with the type of general anesthesia after

Table 2

Comparison of QoR-15 scores between IH and TIVA groups.

	The first postoperative day			The second postoperative day		
QoR-15	IH	TIVA	*P*	IH	TIVA	*P*
1. Able to breathe easily	8.4 (2.2)	8.7 (2.0)	.484	8.9 (1.9)	8.6 (2.1)	.499
2. Have been able to enjoy food	7.6 (2.3)	7.5 (2.9)	.767	8.5 (2.0)	8.2 (2.0)	.362
3. Feeling rested	6.3 (2.4)	6.4 (2.4)	.775	7.4 (2.3)	7.3 (1.9)	.782
4. Have had a good sleep	7.1 (2.4)	6.5 (2.7)	.205	7.1 (2.5)	6.7 (2.1)	.331
5. Able to look after personal toilet and hygiene unaided	8.2 (2.3)	8.6 (2.0)	.317	8.6 (2.2)	9.2 (1.2)	.080
6. Able to communicate with family or friends	9.3 (1.4)	9.5 (0.9)	.343	9.6 (1.0)	9.7 (0.8)	.595
7. Getting support from hospital doctors and nurses	9.5 (1.1)	9.6 (1.1)	.646	9.5 (1.2)	9.6 (1.1)	.798
8. Able to return to work or usual home activities	5.5 (3.1)	5.8 (3.1)	.611	6.5 (3.1)	6.8 (2.7)	.548
9. Feeling comfortable and in control	7.8 (2.4)	7.9 (2.1)	.758	8.1 (2.2)	8.4 (1.8)	.376
10. Having a feeling of general well-being	7.9 (2.1)	7.6 (2.1)	.431	8.2 (2.2)	8.2 (2.0)	.962
11. Moderate pain	6.7 (2.6)	6.9 (2.8)	.829	7.5 (2.5)	7.8 (2.3)	.541
12. Severe pain	8.7 (2.2)	8.7 (2.2)	.860	8.4 (2.4)	8.5 (2.7)	.762
13. Nausea or vomiting	8.9 (1.9)	8.5 (2.4)	.300	9.1 (2.2)	8.7 (2.4)	.447
14. Feeling worried or anxious	8.1 (2.5)	7.5 (2.6)	.233	7.9 (2.6)	7.7 (2.5)	.595
15. Feeling sad or depressed	8.9 (2.0)	8.9 (1.6)	.913	8.5 (2.4)	8.6 (2.4)	.805
Total score	118.9 (21.3)	118.5 (20.0)	.921	123.8 (21.6)	123.0 (17.5)	.960

Data are presented as mean (standard deviation).
IH = inhalation anesthesia, QoR-15 = 15-item Quality of Recovery Score, TIVA = total intravenous anesthesia.

Table 3

Multivariate regression analysis of factors associated with quality of recovery.

	The first postoperative day		The second postoperative day	
	β (95% CI)	*P*	β (95% CI)	*P*
Age (yr)	0.54 (−0.13, 1.21)	.110	0.32 (−0.319, 0.959)	.323
Body mass index (kg/m^2)	2.14 (0.18, 4.11)	.033*	1.97 (0.092, 3.842)	.040*
Operation time (min)	−0.01 (−0.08, 0.06)	.729	−0.03 (−0.095, 0.043)	.456
Type of general anesthesia		.874		.892
IH	0.68 (−7.84, 9.81)		0.56 (−7.583, 8.698)	
TIVA	Reference		Reference	
Use of steroids*		.115		.159
Yes	7.23 (−1.78, 16.25)		6.16 (−2.447, 14.77)	
No	Reference		Reference	
Use of antiemetics*		.989		.671
Yes	−0.07 (−9.59, 9.46)		1.95 (−7.143, 11.05)	
No	Reference		Reference	

* $P < .05$.

adjusting for age, BMI, operation time, use of steroid, and use of antiemetics.

In this study, the patients in the IH group took significantly more antiemetics than those in the TIVA group; however, both groups had similar good quality of recovery on the first and second postoperative days. The multivariate analysis also did not reveal the significant association between the use of antiemetics and QoR-15 total scores. Therefore, the results suggested that PONV is controllable by appropriate management,[21] and the type of general anesthesia may not be the most critical factors of quality of recovery in the patients undergoing transaxillary endoscopic breast augmentation. Other factors, such as skilled surgeons and experienced anesthesiologists, may play more important role in quality of recovery in this selected population.

Although most of the previous studies favored TIVA for quality of recovery, the results regarding the association of the type of general anesthesia and quality of recovery were mixed. In comparing the effects of TIVA with those of IH for thyroid surgery,[4] laparoscopic sleeve gastrectomy,[5] and transabdominal robotic-assisted laparoscopic surgery,[6] quality of recovery was better with TIVA than with IH. However, for ambulatory gynecological surgeries, the results of De Oliveira et al did not support the use of TIVA over IH (sevoflurane) in improving the global quality of recovery.[7]

The major reason contributing to the nonsignificant association between the type of general anesthesia and quality of recovery in this study was that both groups had good quality of recovery. According to the study by Stark et al, QoR-15 scores were normally distributed and the 50th, 75th, and 90th percentiles were 103, 118, and 130, respectively.[12] Our results showed that the QoR-15 total scores in both groups had achieved the 75th percentile on the first postoperative day and been better on the second postoperative day, suggesting both groups had good quality of recovery. Because of the uniformly good results, the differences between the 2 groups were consequently minimized and led to nonsignificant results.

In addition, there were 2 possible explanations for the uniformly good quality of recovery. The first was that patients in both groups had highly homogeneous characteristics, including young women, normal BMI, and ASA classification I or II. Second, compared with conventional breast augmentation, abdominal surgeries, or gynecological surgeries, endoscopic breast augmentation is less invasive with smaller wounds and less blood loss.[5–7,18]

Results of the present study showed that patients with higher BMI had significantly better quality of recovery, which has been reported previously.[22] As Lee et al reported, the protective effect of nutritional status in obese patients was suggested to contribute to better postoperative recovery.[22] In the study by Suemitsu et al, however, obesity was considered to be a risk factor for perioperative complications in thoracic surgeries,[23] clearly suggesting that BMI may negatively influence postoperative recovery scores. In the present study, even though all patients had normal BMI and were relatively young and healthy, we still observed the significant effects of BMI on the quality of recovery. Potential mechanisms of this BMI influence deserve further study.

To the best of our knowledge, this is the first study to compare quality of recovery of IH versus TIVA in patients undergoing transaxillary endoscopic breast augmentation; however, this study must also acknowledge several limitations. First, it was a single-institution study and all surgeries were performed by the same plastic surgeon. Therefore, the results may not be applicable to other institutions or surgeons. Also, results of this study may not be applicable to other surgical procedures. Second, quality of recovery was only evaluated on the first and second postoperative days, and not at any other time points. Thus, we cannot accurately compare the quality of recovery immediately after surgery or compare the speed of recovery between IH and TIVA groups. Additionally, the patients in this study were highly homogeneous and the results showed no associations between the type of anesthesia used and the quality of recovery. This may suggest that the type of general anesthesia is not the most important associated factor for quality of recovery. More studies are necessary to investigate potentially stronger associated factors.

5. Conclusions

For the patients undergoing transaxillary endoscopic breast augmentation, the type of general anesthesia was not associated with quality of recovery. Patients receiving IH or TIVA both had good quality of recovery demonstrated by high total scores of the QoR-15 scale. The results suggested that the type of general anesthesia may not be the most critical factors of quality of

recovery in the patients undergoing transaxillary endoscopic breast augmentation.

Author contributions

C-CH provided study concepts and performed literature review, surgical procedures, clinical care and follow-ups, data analysis, and manuscript writing. K-CH performed study design, definition of intellectual content, manuscript review, and guarantor of integrity of the entire study. All authors read and approved the final version of the manuscript.
Conceptualization: Kuo-Cherh Huang.
Formal analysis: Chih-Cheng Hung.
Investigation: Chih-Cheng Hung, Kuo-Cherh Huang.
Supervision: Kuo-Cherh Huang.
Validation: Kuo-Cherh Huang.
Writing – original draft: Chih-Cheng Hung.
Writing – review & editing: Kuo-Cherh Huang.

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