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Do Anesthetic Techniques Affect Operating Room Efficiency? Comparison of Target-Controlled Infusion of Propofol and Desflurane Anesthesia in Breast Cancer Surgery

Jia-Lin Chen[1], Chang-Po Kuo[1], Yi-Fang Chen[2], Yi-Wen Chen[2], Jyh-Cherng Yu[3], Chueng-He Lu[1], Chun-Chang Yeh[1], and Zhi-Fu Wu[1*]

[1]Department of Anesthesiology, [3]Department of Surgery, Tri-Service General Hospital, National Defense Medical Center, Taipei;
[2]Department of Nursing, National Taiwan University Hospital, Taipei, Taiwan, Republic of China

Background: Anesthetic techniques may contribute to the reduction of operating room (OR) costs by decreasing anesthesia-controlled time. Anesthesia induction and emergence have to be time-optimized without neglecting patient care. The purpose of this study was to compare total intravenous anesthesia (TIVA group) and desflurane anesthesia (desflurane group) with respect to OR efficiency and the incidence of postoperative nausea and vomiting (PONV) in breast cancer surgery. **Design:** Retrospective clinical study. **Methods:** Information from the anesthesia database of the Tri-Service General Hospital for January 2010 to December 2011 was retrieved for patients who underwent breast cancer surgery. Three hundred and sixteen patients were included in the TIVA group (n = 196) or the desflurane group (n = 120). Emergence from anesthesia, OR time, and PONV were compared. **Results:** Emergence time was significantly shorter in the TIVA group than in the desflurane group (4.5±4.6 min vs. 10.4±6.4 min; $P < 0.01$). There were no significant differences in postanesthesia recovery (PAR) discharge time between the groups. However, the total OR stay time was significantly shorter in the TIVA group than in the desflurane group (167±34 min vs. 173 ± 33 min; $P < 0.05$). Increased PONV (30.9% vs. 12.2%; $P < 0.01$) and antiemetic usage (19 vs. 5; $P < 0.05$) were reported in the desflurane group compared with the TIVA group. **Conclusion:** TIVA provided faster emergence, increased OR efficiency, and decreased PONV compared with desflurane anesthesia in breast cancer surgery.

Key words: operating room efficiency, breast cancer surgery, target-controlled infusion, propofol, desflurane

INTRODUCTION

Considering the increasing cost in today's healthcare systems, it is essential that the cost-effectiveness in the field of anesthesia be analyzed in routine clinical practice. Process analysis allows the foundation of potential cost reduction, which in turn allows the optimization of ever-decreasing resources.[1] In Taiwan, a new system of Diagnosis Related Groups (DRGs) has taken part in hospital billing services since 2010. This means that the previous billing system will no longer be valid for current anesthesia costs in the operating room (OR). Instead, one sum payment for one case, selection of the anesthetic technique has to be determined: cheaper agents and least possible anesthesia-controlled time to remain competitive in the operating field.[2] Therefore, the choice of anesthetics may have an important impact on the total costs incurred by an anesthesia department.[3,4]

In addition, process analysis in surgical and anesthetic procedures is becoming increasingly important because it may identify opportunities for optimizing resource utilization. This is particularly important in OR because 33% of total hospital costs for surgical care are dedicated to OR. Anesthesia care could contribute to the reduction in OR costs by decreasing anesthesia-controlled time[5]. Therefore, anesthesia induction and emergence from anesthesia have to be optimized for time without neglecting patient care. However, few reports in the literature have discussed the inference of anesthetic techniques on OR efficiency.

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*Corresponding author: Dr. Zhi-Fu Wu, Department of Anesthesiology, Tri-Service General Hospital, National Defense Medical Center, No. 325, Sec. 2, Cheng-gong Road, Taipei 114, Taiwan, Republic of China. Tel: +886-2-87927128; Fax: +886-2-87927127; E-mail: aneswu@gmail.com

To evaluate potential resources for reducing OR time, we performed a retrospective study that compared anesthesia-controlled time between total intravenous anesthesia (TIVA) with propofol/fentanyl and desflurane anesthesia.

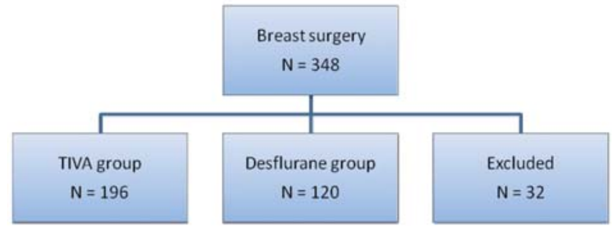
MATERIALS AND METHODS

Patients

This retrospective study retrieved information from the electronic database and medical records of the Tri-Service General Hospital (TSGH; Taipei, Taiwan, Republic of China). The Ethics Committee of TSGH approved the study (TSGHIRB No: 100-05-168). We enrolled 348 patients (ASA class II-III) who received elective breast cancer surgery, including modified radical mastectomy and breast-conserving surgery (lumpectomy with or without axillary dissection), performed by the same surgeon from January 2010 to December 2011 (Figure). Patients who received TIVA or desflurane anesthesia were included. Exclusion criteria were <18 years of age, emergent surgeries, combined inhalation anesthesia with propofol or other inhaled anesthetics in addition to desflurane, or incomplete data.

Anesthetic techniques used in our routine practice

No medication was administered prior to induction of anesthesia; however, regular monitoring, such as electrocardiography (lead II) and measurement of pulse oximetry, noninvasive blood pressure, respiratory rate, and end-tidal carbon dioxide pressure ($EtCO_2$), was performed. TIVA was induced using intravenous (i.v.) fentanyl (2 μg/kg) and 2% lidocaine (1.5 mg/kg). Subsequently, continuous infusion of propofol (Fresfol 1%) was delivered using Schneider's kinetic model of target-controlled infusion (TCI) (Fresenius Orchestra Primea; Fresenius Kabi AG, Bad Homburg, Germany) with the effect-site concentration (Ce) of 4.0 μg/mL. For desflurane anesthesia, the patients were induced with i.v. fentanyl (2 μg/kg), 2% lidocaine (1.5 mg/kg), and propofol (1.5-2 mg/kg). When patients lost consciousness, 0.6 mg/kg of rocuronium was administered, followed by endotracheal intubation and administration of i.v. dexamethasone (5 mg) to prevent PONV (in all patients). For TIVA, anesthesia was maintained using TCI with a propofol Ce of 3-4 μg/mL under an oxygen flow of 300 mL/min. In patients anesthetized with desflurane, anesthesia was maintained using 8%-12% desflurane (inhaled concentration) in an oxygen flow of 300 mL/min under a closed system without nitrous oxide. Ce for TCI propofol was adjusted at the range of 0.2 μg/mL and desflurane 0.5% according to the hemodynamics. If two increments or decrements were unsuccessful, the range of Ce for TCI propofol and desflurane was increased to 0.5 μg/mL or 2%, respectively. Ventilation rate and maximum airway pressure were adjusted to maintain the $EtCO_2$ pressure at 35-45 mmHg. Cisatracurium (2 mg) was administered as required to antagonize the return of neuromuscular function.[6]



Flow diagram

At the end of the surgery, during wound closure, propofol was adjusted to a Ce of 2.0 μg/mL and the vapor of desflurane was changed to 5.0%. At the beginning of skin closure, desflurane or propofol were discontinued. After gauze coverage, the lungs were ventilated with 100% oxygen at a gas flow of 6 L/min. When the patient regained consciousness with smooth respiration, the endotracheal tube was removed and the patient was sent to the postanesthetic recovery room (PAR) for further care. Aldrete scores were recorded on arrival, 15 minutes later, and at discharge from the PAR by PAR staff. Intravenous medications administered in PAR included an analgesic (fentanyl, 25-50 μg), an antiemetic (dehydrobenzperidol, 1.25 mg), or an anti-shivering agent (meperidine, 25-50 mg). PONV and other adverse side effects were documented.

Objective

The primary outcome measures of this study were anesthesia time, emergence time, and total OR and PAR time. Anesthesia time was defined as the time from the beginning of preoxygenation (approximate start of fentanyl administration) to the removal of the endotracheal tube. Surgery time was defined as the time from skin incision to the end of dressing coverage. Emergence time was defined as the time from the end of surgery to extubation. Total PAR time was defined as the time of discharge from OR to discharge from PAR. Total OR time was defined as the time from anesthesia induction to discharge from PAR.

Statistics

Data are presented as the mean and standard deviation (SD), number of patients, or percentage. Demographic and perioperative data were compared using Student's *t* test. The comparison between groups was performed using the paired *t*-test. The Mann-Whitney *U* test was used for further analysis of nonparametric variables. Categorical variables were tested using either chi-squared statistics or the Fisher's exact test. A P value of <0.05 was considered statistically significant.

RESULTS

We excluded 32 patients from the analysis: 12 patients received combined inhalation anesthesia with propofol, eight patients received sevoflurane anesthesia, and 12 patients had incomplete data.

The two groups were similar with respect to demographics, surgical time, and anesthesia time (Table). Emergence was significantly faster (4.5±4.6 min vs. 10.4±6.4 min; $P < 0.01$) and the total OR time was shorter (167±33.9 min vs. 173±32.7 min; $P < 0.05$) in the TIVA group compared with the desflurane group. The Aldrete score on arrival at PAR and discharge from PAR was not different between the groups. Moreover, the surgery, anesthesia, and PAR time were not different between the groups. After desflurane/fentanyl anesthesia, significantly more patients suffered from PONV compared with the TIVA group (30.9% vs. 12.2%; $P < 0.01$), and used more antiemetics (19 vs. 5; $P < 0.05$).

Patient's characteristics and time measurement

	TIVA group (n = 196)	Desflurane group (n = 120)	P
ASA II/III	96/100	56/64	
Age (y/o)	51.6 ± 6.5	51.1 ± 7.8	P = 0.288
Height (cm)	158.7 ± 5.2	158.4 ± 5.2	P = 0.899
Weight (kg)	57.0 ± 8.2	56.5 ± 8.6	P = 0.356
Surgery time (min)	103.2 ± 28.1	103 ± 28.0	P = 0.254
Anesthesia time (min)	115.8 ± 28.3	119.3 ± 27.2	P = 0.209
Emergence time (min)	4.5 ± 4.6	10.4 ± 6.4	P < 0.01
PAR time (min)	51.7 ± 16.8	54.0 ± 16.8	P = 0.145
Total OR time (min)	167 ± 33.9	173 ± 32.7	P = 0.048
Aldrete score (PAR arrival)	9	9	P = 1
Aldrete score (PAR discharge)	10	10	P = 1
PONV	24 (12.2%)	38 (30.9%)	P < 0.01
Rescue for PONV	5	19	P = 0.032
Hospital days	4	4	P = 1

DISCUSSION

The major findings of this retrospective study were that TIVA improved OR efficiency and decreased PONV compared with desflurane anesthesia in breast cancer surgery. These results were in line with our previous studies; we had demonstrated that the emergence time was shorter when using TCI with propofol regimen compared with desflurane.[7,8]

The OR and PAR are high-dependency areas that contribute markedly to the costs of the anesthesia department; therefore, shortening total OR time may lead to a reduction in overall costs.[9] Faster emergence is related to rapid OR turnover rate, which would decrease workload on the PAR staff, resulting in savings. Moreover, TSGH requires the anesthesia staff to observe patients in PAR for at least 30 min after general surgery. Although the emergence time in the TIVA group was significantly shorter, there was no difference in PAR time between the groups included in this study. This may have been caused by multiple nonmedical and administrative factors related to PAR time.[10]

Many approaches can be used to increase OR efficiency. For example, Dexter and Macario[11] showed that using a computer simulation may decrease total OR time and save working time, in turn allowing the performance of more procedures within normal working hours. To the best of our knowledge, we have demonstrated for the first time in a retrospective study that different general anesthetic techniques have an impact on the OR efficiency.

The economic analysis of anesthesia regimens is necessary for cost savings. Propofol is popular in general anesthesia, particularly in the ambulatory setting. It is often used in combination with remifentanil because both drugs enable rapid emergence and early return to normal activities.[12-15] However, remifentanil has only recently become available in Taiwan, and propofol is cheaper in Taiwan than it is in America or Europe.[7] Our previous studies showed that TIVA with propofol and fentanyl is more cost-saving than desflurane anesthesia with respect to both short-term and prolonged surgery.[7,8]

In this retrospective study, almost all patients had more than two risk factors of PONV;[16] therefore, the anesthesiologists added i.v. dexamethasone to prevent this condition. As propofol has been documented for preventing PONV,[17,18] we found that the incidence of PONV and the need for antiemetics were significantly lower in the TIVA group than in the desflurane group.

Some studies failed to show any clinical difference in emergence time between TIVA and inhalation anesthesia.[19-22] The systemic review performed by Gupta *et al*. revealed that time to eyes opening and time to obeying commands were significantly shorter for desflurane compared with propofol anesthesia.[22] These findings were different from those of this retrospective study and our previous studies.[7,8] This discrepancy may have been caused by different propofol delivery techniques (the TCI system vs. syringe pump infusion). The TCI system uses an averaged pharmacokinetic model to control the infusion rate and the calculated plasma concentration directly, rather than indirect control provided by adjusting the infusion rate.[23] Comparative studies between TCI and manual infusion showed faster recovery associated with the former.[24] However, Dold *et al*.[21] reported a shorter emergence time for desflurane compared with propofol delivered using the TCI technique in patients undergoing knee surgery. In another study, the anesthetic regimens of inhalation anesthesia with desflurane and TCI with propofol were compared, but no significant difference was observed in terms of recovery profiles.[25] In addition, Mahli *et al*.[26] reported that there was no significant difference in emergence time between propofol delivered by TCI or desflurane delivered by anesthetic regimens in ear, nose, and throat surgery. In the present study, emergence time was longer than that recorded in previous reports. These differences may have been caused by the fact that the concentration of desflurane was lower in the combination with nitrous oxide use in the study of Dold *et al*.[21] The flow rate of oxygen used for desflurane maintenance was also different: 1-4 L/min[25,26] vs. 300 mL/min in our practice. We did not use a high gas flow after discontinuing desflurane during skin closure, which took approximately 5 min, and used closed-circuit anesthesia, which may also prolong the neuromuscular blockade and delay spontaneous breathing.[27] Nevertheless, because our number of cases was much larger than that included in previous reports, the investigators' bias may have been decreased and the results reflect better reality of our clinical practice.

Ce of propofol (3-4 μg/mL) and desflurane (8%-12%) anesthesia were those used in our daily practice for breast cancer surgery. It is unclear whether these conditions provide similar anesthetic depth. Few studies have translated the concentration of propofol into desflurane concentration. However, our previous studies, which were performed under auditory evoked potentials monitoring,[7,8] showed that a Ce of 3-4 μg/mL propofol has similar effects to a concentration of 8%-12% desflurane .

The present study had some limitations. First, it was not a prospective, double-blind and randomized study. Second, the patient group included only women, and the subtype of the breast cancer surgery was not subgrouped or compared. Third, no anesthetic depth monitors used in this retrospective study. However, in our routine practice and in the practice of most anesthesiologists in Taiwan, no anesthetic depth monitoring, e.g. BIS, is used during minor surgery such as breast cancer surgery. Moreover, many studies[28,29] have suggested an absence of benefit of BIS monitoring during clinical anesthesia. Fourth, there were many biases (different attending anesthesiologists and nurse anesthetists) in this study; however, the data were retrieved from an electronic database and the results reflected the reality of the common practice of our hospital.

In conclusion, our results showed that TIVA through TCI with propofol may improve OR efficiency in breast cancer surgery. This increase in efficiency may also decrease the anesthesia-related complication of PONV and increase patient safety and satisfaction. However, prospective, double-blind and randomized studies are warranted.

DISCLOSURE

The authors declare that this study has no conflict of interest.

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