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Inhalation vs total intravenous anesthesia for robot-assisted thymectomy

Abstract

Introduction: Robot-assisted thoracoscopic thymectomy (RATT) allows fine control of surgical movements but often requires one-lung ventilation, prolonged intubation and post operative observation in the intensive care unit. We conducted a retrospective chart review to compare the use of inhalation anesthesia versus total intravenous anesthesia in robot-assisted thoracoscopic thymectomy.

Methods: Nineteen patients diagnosed with either myasthenia gravis or thymoma who underwent RATT were included in this review. All patients underwent a left-sided, three-port or four-port thymectomy. The da Vinci surgical robot was located over the patient's right shoulder and patients were positioned in either the anterolateral angle or lateral decubitus, with a roll under the left chest. Robotic entry ports were inserted through the 5th intercostal interspace. Specific collected parameters included pre-medications and anesthetics administered, ease of one lung ventilation during the procedure, time to post-operative extubation and complications.

Results: Seventeen of 19 patients (89%) tracheas were extubated in the operating room although 18 of 19 patients (95%) were admitted for further observation to the intensive care unit. Total intravenous anesthesia was administered to ten patients (53%) and inhaled gas anesthetics were administered to nine (47%) patients. Neuromuscular blocking drugs were administered intra-operatively to 10 patients. No significant differences in outcome were observed between patients receiving total intravenous anesthesia or inhalation anesthesia. No serious intraoperative, postoperative or late post operative complications were observed following ICU admission with either total intravenous anesthesia or inhalation anesthesia.

Conclusion: Early extubation and direct admission to the ward following post anesthesia care unit discharge may be feasible with both methods of anesthesia for RATT.

Keywords: Myasthenia gravis; Thymoma; Da Vinci Robot, Thymectomy, Anesthesia

Volume 1 Issue 3 - 2014

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Received: May 02, 2014 | **Published:** July 11, 2014

Abbreviations: RATT, Robotic Assisted Thoracoscopic Thymectomy; OLV, One Lung Ventilation; MG, Myasthenia Gravis; TIVA, Total Intravenous Anesthesia; ETT, Endotracheal Tube; PACU, Post Anesthesia Care Unit; ICU, Intensive Care Unit; SLT, Single Lumen Tube; DLT, Double Lumen Tube; VAS, Visual Analog Scale; OR, Operating Room

Introduction

With the advent of robotic-assisted thoracoscopic thymectomy (RATT), increased surgical precision and resolution of symptoms has been observed for treatment of myasthenia gravis (MG). Compared to transsternalthymectomy, RATT results in less blood loss, better aesthetic sequelae, lower complications, less postoperative pain and decreased length of hospital stay.[1–3] Despite of this, the anesthetic implications and associated complications have not been widely documented and present new challenges to the anesthesiologist. Common anesthetic practice for RATT includes one lung ventilation (OLV), prolonged intubation after surgery and minimal neuromuscular blockade use due to the fear of postoperative myasthenic crisis.[4,5] The positioning of the robotic arms adds additional concerns such as intraoperative patient injury and accidental extubation. A 2010 retrospective study analyzed on anesthesia for RATT and found several complications that the authors attribute to patient positioning, robotic arm positioning/compression, and port location.[6] Of the 17 patients reviewed, all suffered from intraoperative arrhythmias and hypotension, two had an accidental pleural rent, one suffered a brachial plexus injury, two awoke with hoarseness of voice, and one encountered ventilatory difficulty.[6]

Currently there are no established anesthetic guidelines for patients undergoing RATT and the impact of this surgical method on anesthetic management remains relatively unknown. We hypothesized that Total intravenous anesthesia (TIVA) could result in faster extubation times and less patients with prolonged intubation following RATT compared to inhalation anesthesia, but currently both methods are used in our practice. The purpose of this study was to analyze our sequence and technique of anesthesia and compare TIVA and inhalation anesthesia for RATT. The aim was to design a standard anesthesia protocol for RATT at our institution.

Materials and methods

After IRB approval, we completed a retrospective chart review of all patients that underwent thymectomy from November 2010 to June 2013 at Tampa General Hospital. We identified 19 cases that utilized RATT (da Vinci Surgical System, Intuitive Surgical, Inc., Sunnyvale, CA). All cases were completed by a single surgeon (KS) and anesthesiologist (DM). Indications for thymectomy were treatment resistant (corticosteroids, immunosuppressive, and anticholinesterase) MG and/or thymoma. The primary objective of this study was to compare inhalation anesthesia to TIVA for time to extubation following the discontinuation of anesthesia. Secondary objectives were to identify any anesthetic complications

related to RATT in our patients. Intraoperative monitoring included electrocardiogram, invasive radial arterial blood pressure monitoring, pulse oximetry (SPO_2), end-tidal CO_2, and non-invasive blood pressure. Induction of anesthesia was obtained by administration of 2-3mg/kg of propofol, 100 mg of lidocaine, and 1.5ug/kg of fentanyl. All patients were intubated with a double lumen endotracheal tube or an oral endotracheal tube (ETT) with an endobronchial blocker. The appropriate position of the double or single lumen ETT was verified with a flexible fiberoptic bronchoscope. Neuromuscular blocking agents were used to facilitate intubation only after two failed attempts by the anesthesiologist. All patients underwent a left-sided, three or four-port thymectomy. The surgical robot was positioned over the patient's right shoulder. Patients were positioned in either the right lateral decubitus position or left anterolateral position with a roll under the left chest. Robotic entry ports were inserted through the left 5th intercostal space.

Patients were categorized as receiving either inhalation anesthesia or TIVA. Such classifications were made after evaluation of administered anesthetics and determining the predominant agent(s) used in each case. Data collected were: patient demographics (age, gender, height and weight), past anesthesia complications, comorbidities, administered anesthetic agents, number of attempts for intubation, type of ETT, surgical time, postoperative pain, post anesthesia care unit (PACU) time, post-PACU admission (ICU or ward), time to extubation, and postoperative complications. Time to extubation was defined as the time of discontinuation of anesthetic agents until the time of ETT removal. Data are expressed as mean±SD or median (range). Due to the small sample size of our study we utilized a non-parametric statistical analysis with the Mann-Whitney U test for comparisons of surgical and anesthetic parameters.

Results and discussion

Table 1 presents the demographics and comorbidities for all patients. Of the 19 patients, nine were classified as receiving inhalation anesthesia and ten classified as receiving TIVA (Table 1). Myasthenia gravis was the diagnosis in 5 patients receiving inhalation anesthesia (26%) and 9 patients receiving TIVA (47%). Thymoma was the diagnosis in four patients receiving inhalation anesthesia (44%) and one patient receiving TIVA (10%). Surgical and anesthetic parameters are presented in Table 2. Anesthesia was maintained with sevoflurane (1.48-2.1%) in nine patients or a continuous infusion of 100 ug/min propofol in ten patients. Sevoflurane was utilized in four TIVA patients intermittently for blunting of hypertensive responses (Table 2). Neuromuscular blockers (succinylcholine, vecuronium or rocuronium) were utilized in 10 patients (53%) of which five were diagnosed with MG (26% of MG patients) and 5 were diagnosed with thymoma (100% of thymoma patients). One lung ventilation was achieved in all patients with either a double lumen endotracheal tube (DLT) (n=16) or with a single lumen endotracheal tube (SLT) with an endobronchial blocker (n=3). The patients that utilized a SLT and an endobronchial blocker had tracheas that were too small to be intubated with the DLT. All patients returned to two-lung ventilation towards the end of the surgical case. Seventeen patient's (89%) tracheas were extubated in the operating room. Two (11%) patients (1 inhalation anesthesia patient and 1 TIVA patient, both DLT intubation) did not meet criteria for extubation at the end of surgery and were extubated in the PACU, 55 and 100 mins respectively after emergence.

No occurrences of hemodynamic instability were observed in the perioperative period of any of the cases. One inhalation anesthesia patient experienced short-lived hypotension and hypertension intraoperatively. Overall, there was no significant difference in time to extubation between the inhalation anesthesia and TIVA patients (p=0.55). One patient in the inhalation anesthesia group experienced a sore throat which upon post-operative laryngoscopy was found to be caused by trauma to the trachea. One TIVA patient developed a left pleural effusion in the first 24 hours postoperatively. Eighteen (95%) patients were admitted to the ICU after their PACU stay, while one patient was admitted directly to the floor. Visual analog (VAS) pain scores were in acceptable ranges for both study groups and were not statistically different.

Table 1 Patient demographics, anesthetic history and administered anesthetic doses

Demographics	Inhalation	TIVA	Total
Female {n (%)}	9 (100)	10 (100)	19 (100)
Age	47.6±17.8	44.0±9.6	45.7±13.8
Height (cm)	161.4±7.5	168.0±4.3	164.9±6.8
Weight (kg)	69.0±12.5	80.2±17.6	74.9±16.1
BMI (kg/m^2)	26.3±4.2	28.3±5.4	27.4±4.8
ASA Class {n (%)}			
2	1 (11)	0 (0)	1 (5)
3	6 (67)	6 (60)	12 (63)
4	2 (22)	4 (40)	6 (32)
Diagnosis {n (%)}			
Myasthenia Gravis	5 (56)	9 (90)	14 (74)
Thymoma	3 (33)	1 (10)	4 (21)
Thymoma with Thymic Hyperplasia	1 (11)	0 (0)	1 (5)
History of Previous Anesthetic Complication {n (%)}			
PONV	1 (11)	1 (10)	2 (11)
Shortness of Breath	1 (11)	4 (40)	5 (26)
Sleep Apnea	1 (11)	0 (0)	1 (5)

Citation: Mangar D, Sprenker C, Karlnoski R, et al. Inhalation vs total intravenous anesthesia for robot-assisted thymectomy. *J Anesth Crit Care Open Access.* 2014;1(3):67–70. DOI: 10.15406/jaccoa.2014.01.00014

Table 2 Anesthetic and surgical parameters, comparisons calculated with Mann-Whitney U-test. Data are presented as median (range)

	Inhalation (n=9)	TIVA (n=10)	P-Value
Time to Extubation (min)	14 (4-60)	10 (0-100)	0.55
Anesthesia Time (min)	205 (129-229)	219 (157-318)	0.32
Surgical Time (min)	137 (79-171)	141.5 (94-256)	0.17
EBL (mL)	25 (0-250)	25 (0-200)	0.86
PACU Time (min)	201 (55-498)	234 (51-429)	0.62
Postop VAS Score	0.5 (0-2)	1 (0-3)	0.44
Chest Tube Time (hours)	27.45 (18.85-72)	33.23 (21.5-39.23)	0.1
ICU Time (days)	1 (0-4.5)	2 (0-6)	0.86
Intraoperative Anesthetic and NMB Dosages			
Sevoflurane (MAC. hour)	2.33 (1.67-2.97)	1.02 (0.34-1.86)	0.02
Propofol Infusion (mg)	0 (0-0)	2261 (1111-3081)	<0.001
Fentanyl (mcg)	250 (100-300)	250 (0-500)	0.65
Ketamine Infusion (mg)	0 (0-0)	36.87 (0-100)	0.01
Rocuronium (mg)	25 (0-80)	0 (0-30)	0.08
Succinylcholine (mg)	0 (0-100)	0 (0-100)	0.71
Vecuronium (mg)	0 (0-12)	0 (0-4)	0.84

PACU, Post Anesthesia Care Unit; ICU, Intensive Care Unit; NMB, Neuromuscular Blocker

Conclusion

Evidence for the use of gas anesthesia or TIVA in RATT has not been previously studied, as the robot-assisted procedure has only recently been introduced to surgical facilities. While complete thymectomy has been used extensively as treatment for thymoma and MG for some time, it is only recently that the robotic approach has shown advantages over the more traditional open trans-sternal approach.[7] The increasing prevalence of this procedure necessitates further investigation of its anesthetic protocol. To this end, our study evaluated two patient groups: a group receiving inhalation anesthesia and a group receiving TIVA.

The determination of whether patients with MG require prolonged intubation postoperatively is of clinical significance. The main finding in the current study was 89% (86% with MG) of patients were extubated in the operating room (OR). Secondly, we found no statistically significant differences in any anesthetic considerations or major complications as a consequence of either type of anesthesia. Although this study only included RATT it is likely our results would translate to the to the trans-sternal technique which are performed on average 40 minutes sooner because of the additional robot docking time in RATT. Neuromuscular blocking agents were utilized in 26% of patients that were treated for MG and all patients with thymoma. No additional complications from the addition of a nicotinic receptor antagonist in the predisposed neuromuscular patient were observed. This lends to the possibility of safe usage of neuromuscular blockers following careful preoperative evaluation of MG patients. The reversal of rocuronium by administering sugammadex may further increase the safety of neuromuscular blockade in MG patients.[8] Interestingly, in the three patients that could not be intubated with a DLT, neuromuscular blocking agents were not utilized.

Our MG patients were profoundly affected by the disease, were admitted to the hospital and managed medically by the neurology group, for several days, before coming to surgery. Medications received in preparation of the thymectomy comprised of acetylcholine inhibitors (all), immunosuppressants (7 patients), intravenous immunoglobulin infusion (5 patients) and plasmpheresis (5 patients). In the past, MG patients were either lightly paralyzed or not at all, as this increases both reversal and extubation times while contributing to overall patient weakness. In the current study rocuronium, vecuronium, or succinylcholine was used in small doses in approximately half of the patients, to assist with intubation of the double lumen tube. We suspect that the subsequent extended amount of time needed to close and undock the robot at the end of the procedure allowed for extubation in the OR or shortly after reaching the recovery room. The longest times recorded throughout the procedure were those recorded from closure to the end of robotic undocking. Without such delays in the OR, extubation would most likely have taken place at a later stage in the recovery process.

The complications experienced by Pandey et al.[6] are alarming and may be due to differences in experience and surgical technique. All patients in their study were transported to the ICU intubated and were weaned off ventilator support within 1-2 hours. This significantly differs from the current study as almost 90% of our patients' tracheas were extubated in the PACU before transport to the ICU. Additionally, all of the patients described in the Pandey et al.[6] study utilized general anesthesia (maintained with sevoflurane). Of our reviewed patients, 10 (53%) utilized TIVA with a continuous infusion of propofol or ketamine. Minimal differences, however, were observed between the two groups of patients in the current study. Although the reported complications and injuries resulting from the use of the robotic arm, they reported no anesthetic concerns from the inhalation anesthesia itself. Rather, they identified possible technical issues due to patient positioning. In an effort to allow ease of robotic access, patient airways and/or nerves were likely compressed as the robotic arm reached across the patient.

Gritti et al.[4] implemented an anesthetic protocol for the management of MG during trans-sternal thymectomy. They retrospectively reviewed 110 patients and found a significant use of neuromuscular blocking agents (65% of patients admitted to ICU and 22% admitted to the surgical ward) before implementing their anesthetic protocol. It is important to note that none of these patients had problems weaning from ventilator support or developed postoperative myasthenic crisis. However after changing their anesthetic protocol they reduced their use by 80% suggesting that it would result in less recovery time. Furthermore myasthenia crisis was observed in only 1.8% of patients

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which they attribute to the use of short acting drugs, minimal use of muscle relaxants, and the minimally invasive nature of the surgery. Our data suggests that prolonged intubation and conservative usage of neuromuscular blockade may not be required in this patient population and direct admission to the surgical ward is possible. However, a large randomized controlled trial is needed to assertively conclude these findings. In conclusion, the perioperative management of RATT with both inhalation anesthesia and TIVA appear to be equally effective and can be utilized with minimal complications.

Funding details

None.

Acknowledgments

None.

Conflicts of interests

Authors declare that there is no conflict of interest.

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