The American Journal of Surgery (2016) 212, 1175-1182

The American Journal of Surgery®

Southwestern Surgical Congress

Comparison of pulmonary function tests and perioperative outcomes after robotic-assisted pulmonary lobectomy vs segmentectomy

Maria F. Echavarria, M.S.[a], Anna M. Cheng, B.S.[a], Frank O. Velez-Cubian, M.D.[b], Emily P. Ng, B.S.[a], Carla C. Moodie, P.A.-C.[c], Joseph R. Garrett, A.R.N.P.-C., M.P.H.[c], Jacques P. Fontaine, M.D.[b,c,d], Lary A. Robinson, M.D.[b,c,d], Eric M. Toloza, M.D., Ph.D.[b,c,d,*]

[a]*Morsani College of Medicine, University of South Florida, Tampa, FL, USA;* [b]*Department of Surgery, University of South Florida, Morsani College of Medicine, 12901 Bruce B Downs Blvd., Tampa, FL 33612, USA;* [c]*Department of Thoracic Oncology, Moffitt Cancer Center, 12902 USF Magnolia Dr., Suite FOB-1, Tampa, FL, USA;* [d]*Department of Oncologic Sciences, University of South Florida, Morsani College of Medicine, 12901 Bruce B Downs Blvd., Tampa, FL 33612, USA*

KEYWORDS:
Lung cancer;
Lobectomy;
Segmentectomy;
Robotic surgery;
Outcomes;
Pulmonary function

Abstract

BACKGROUND: Lobectomy is standard treatment for early-stage lung cancer, but sublobar resection remains debated. We compared outcomes after robotic-assisted video-assisted thoracoscopic (R-VATS) segmentectomy vs lobectomy.

METHODS: We retrospectively analyzed data from 251 consecutive patients who underwent R-VATS lobectomy (n = 208) or segmentectomy (n = 43) by a single surgeon over 36 months. Pulmonary function tests and perioperative outcomes were compared using Chi-squared test, unpaired Student *t* test, or Kruskal–Wallis test, with significance at $P \leq .05$.

RESULTS: Intraoperative complications were not significantly different, but median operative times were longer for R-VATS segmentectomies ($P < .01$). Postoperative complications were not significantly different, except for increased rates of pneumothorax after chest tube removal ($P = .032$) and of effusions or empyema ($P = .011$) after R-VATS segmentectomies. Predicted changes for forced expiratory volume in 1 second and diffusion constant of the lung for carbon monoxide are significantly less after R-VATS segmentectomy ($P < .001$).

E.M.T. and J.P.F. have had financial relationships with Intuitive Surgical Corporation in form of honoraria as robotic thoracic surgery proctors and observation sites.

No other authors have any conflicts of interest or financial ties to disclose.

This article is an update of our study previously presented at the 2014 International Association for the Study of Lung Cancer (IASLC) Asia Pacific Lung Cancer Conference (APLCC2014) in Kuala Lumpur, Malaysia, on November 7, 2014; at the 2015 Society of Robotic Surgery Annual Meeting in Orlando, FL; in February, 2015; and at the 2016 Southwestern Surgical Congress in San Diego, CA, on April 5, 2016.

* Corresponding author. Tel.: +1-813-745-6895; fax: +1-813-449-8387.
E-mail address: eric.toloza@moffitt.org

Manuscript received March 18, 2016; revised manuscript September 4, 2016

http://dx.doi.org/10.1016/j.amjsurg.2016.09.017

CONCLUSIONS: R-VATS segmentectomy should be considered as an alternative to lobectomy for conserving lung function in respiratory-compromised lung cancer patients, although oncologic efficacy remains undetermined.

Lobectomy with mediastinal lymph node dissection (MLND) is the gold standard surgical treatment of early-stage nonsmall cell lung cancer (NSCLC).[1] An alternative anatomic resection to lobectomy is segmentectomy, especially for poor surgical candidates with limited cardiopulmonary function.[2,3] Several factors are usually considered when offering a segmentectomy to a patient. These factors include tumor size and location, forced expiratory volume in 1 second (FEV1), previous lung resection, extent of pleural adhesions, incomplete fissure, and presence of calcified and anthracotic lymph nodes.[4] Segmentectomy is still a controversial topic due to its complexity and fear of increased risk of local recurrence. However, recently published data suggest that segmentectomy, either via open or conventional video-assisted thoracoscopic approach, has equivalent outcomes as lobectomy for early-stage NSCLC.[4]

Low FEV1 is a major limiting factor in lung tumor resection because it has been reported to have an increased morbidity and mortality. Patients with a FEV1 percent of predicted (FEV1%) of 35% to 40% have increased morbidity and mortality.[5] For example, prolonged air leaks increase with low-predicted postoperative FEV1.[5] In comparison to lobectomy, segmentectomy is better at preserving pulmonary function by decreasing vital capacity and FEV1 less than lobectomy in patients with significantly worse chronic obstructive pulmonary disease (COPD) and preoperative pulmonary function tests (PFTs).[6] Also, segmentectomy has less effect on pulmonary anatomy than lobectomy, which can significantly affect pulmonary function. Patients undergoing right upper lobectomy have been observed to develop an upward bend of the right middle lobar bronchus, which can lead to a more drastic reduction in postoperative FEV1.[7] All postoperative PFTs are affected by pulmonary disease, type of resection, and side of operation.[5–7]

Because the introduction of minimally invasive surgery and the approval by the United States Food and Drug Administration (FDA) of robotic surgical systems, such as the Da Vinci system (Intuitive Surgical Corporation, Sunnyvale, CA), increased numbers of oncological procedures have been performed with these modalities. This newer robotic technology provides surgeons the ability of having a 3-dimensional view, a stable camera port, absence of fulcrum effect, and multiple degrees of freedom of movement due to "wristed" instruments. The robotic system facilitates intracorporeal suturing with the wrist-like movements, cancels surgeons' tremors, and improves ergonomic benefits. However, robotic-assisted VATS (R-VATS) surgery does not provide tactile feedback, can result in instrument collision when covering wide surgical fields, and has a steep learning curve, which requires a high degree of dexterity and technical skill.[4]

Published comparisons between conventional VATS, R-VATS, and open lobectomy and segmentectomy have been reported. Benefits of R-VATS surgery have been published, such as decreased postoperative pain, shorter hospital length of stay (LOS), and a quicker return to daily activities. Yet, the safety profiles and oncologic outcomes of R-VATS surgery are reported to be comparable to those of open or conventional VATS approaches.[4]

The goal of our study was to compare perioperative outcomes after R-VATS lobectomy vs R-VATS segmentectomy. This study is one of the first comparison studies between these 2 procedures using the robotic approach.

Methods

We retrospectively analyzed prospectively collected data of consecutive lung cancer patients who underwent R-VATS lobectomies or R-VATS segmentectomies by a single surgeon at our institution from September 2010 through August 2013. Some patients were offered a segmentectomy based on a combination of tumor size and location, PFTs, presence of other proven or suspected malignant lung tumors, prior lung resection, cardiac comorbidities, dyspnea, and patient preference due to their lifestyle and potential effect of loss of lung function on their quality of life. Medical charts were retrospectively reviewed to assess intraoperative and postoperative complications for those patients who underwent either resection via R-VATS. We excluded patients who underwent a pneumonectomy or only wedge resection(s), but we did not exclude patients converted to open lobectomy. Patients with other pathologies besides NSCLC were also excluded from our study.

This study was conducted in accordance with the amended Declaration of Helsinki as outcomes research for quality assurance as part of our departmental thoracic oncology clinical research database protocol. This database protocol was approved by our institution's Scientific Review Committee (MCC #16512) and our university's Institutional Review Board (IRB #Pro00002678), which waived informed consent for this retrospective study, which is considered as review of existing data. Nevertheless, all patients gave informed consent for our standard surgical procedure, which consists of fiberoptic bronchoscopy, R-VATS lobectomy or segmentectomy or else R-VATS wedge resection, followed by R-VATS completion lobectomy or segmentectomy, and MLND, with possible thoracotomy. Some patients also gave informed consent for any anticipated en bloc chest wall and/or vertebral resection, with possible chest wall and/or vertebral reconstruction. Through our institutional surgical informed consent,