Editorial

Robotics - The answer to the *Achilles' heel* of VATS pulmonary resection

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During the past decade, robotic surgical systems have been increasingly utilized to perform highly complex surgical procedures. In fact, the robotic-assisted approach to the treatment of many gynecological and urological surgical procedures has become the standard-of-care. The use of robotic surgical system in thoracic surgery is in its early development. Video-assisted thoracoscopic surgery (VATS) was propelled forward in the early 1990's without full appreciation for long-term consequences, increased cost or therapeutic benefit. The trend in robotic-assisted thoracic surgery is projected to surpass the adoption of VATS and to mirror that of other robotic surgical subspecialties.

The efforts of many pioneers who helped develop advanced VATS techniques have resulted in major benefits to patients undergoing wide spectrum pulmonary surgery. The literature has demonstrated complication rates are less; quality of life and recovery time is improved, and costs over time to the system favored the then new technology VATS over the open approach (1). As the science has matured, the long-term outcomes and survival data has established that VATS is at a minimum equivalent to thoracotomy for early-stage disease. Unfortunately, even after twenty years of enhancing the instrumentation for the VATS approach, standardization of the VATS technique remains elusive. Despite the superior outcomes of VATS compared to thoracotomy, review of STS database substantiate limited adoption of VATS (2). Therefore, VATS cannot be acknowledged as the "Standard-of-care" for the treatment of pulmonary malignancies.

The advantages and safety of VATS technology for pulmonary resection has been clearly demonstrated within the literature. However, what is also apparent is that the majority of published series have limited the use of VATS to the treatment of early-stage I non-small cell lung cancer (NSCLC). Advocates for VATS lobectomy argue that robotic technology does not currently add benefit to the field of thoracic surgery and pulmonary resection. They argue that VATS technology allows safe isolation and division of hilar structures as well as complete mediastinal lymphadenectomy in the majority of cases. However, the latest analysis of the STS database confirms that VATS pulmonary resection is utilized to manage the minority of operable NSCLC cases. In the national inpatient database, one that reflects a broader scope of community-based and academic surgeons, the percentage of patients with NSCLC undergoing resection utilizing a minimally invasive surgical approach is less than 10% (2). Since VATS lobectomy is predominantly limited to the treatment of early-stage NSCLC, equivalency of the VATS platform to conventional surgery can not be made in the treatment of more advanced disease nor larger centrally located tumors; criteria that are frequently used to exclude patient for minimally invasive surgical resection.

The manuscript discusses numerous studies that have demonstrated that robotic-assisted surgery is feasible and safe for major pulmonary resection and is associated with comparable morbidity and mortality to that of open and VATS pulmonary resection (3). Many who have embraced robotic-assisted thoracic surgery strongly believe that the technological advancement over VATS will be validated by further study. The miniaturized, wrist instruments and the high-definition, 3-dimensional camera blended with computerized, intuitive integration of the surgeon's fundamental surgical abilities offers unique advantages over traditional minimally invasive surgery. The design of the robotic platform surmounts the inherent challenges

of video-assisted surgery such as 2-dimensional imaging, counter-intuitive orientation and crude instrumentation. Robotic assisted surgery allows the surgeon to establish optimum exposure in a limited operative space, while being able to perform precise maneuvers around critical structures, features that facilitate safe dissection of the vascular anatomy and systematic removal of disease in a broader scope of lung cancer patients. Pardolesi and colleagues (4) demonstrated that robotic anatomic segmentectomy was easier to adopt and associated with no major morbidity or mortality. In the lead authors' published series of 200 consecutive patients presenting with a wide range clinically operable tumors, 197 (98.5%) patients were successfully completed with a complete port-based robotic assisted technique (5). This series demonstrated that a broad population of patients presenting with early-stage, locally advanced disease and complex cases, requiring pneumonectomy, chest wall resection and sleeve resection can be reliably managed, using a robotic assisted minimally invasive approach. For the most part, robotic technology allows surgeons to replicate their preferred technique now using a minimally invasive approach. Advancements achieved in medical simulation should shorten the learning curve and increase the use of minimally invasive lobectomy. Thus, wider adoption is inevitable and the economic benefits to society are immeasurable.

The most prevalent argument against robotic-assisted pulmonary resection is the hypothetical belief that the costs of robotic surgery will be substantially greater than that of traditional open or VATS pulmonary resection. Two retrospective analyses of VATS lobectomy compared to traditional thoracotomy and lobectomy demonstrated that VATS lobectomy cost less ranging from $300 - $2,000 dollars (6,7). Park and colleagues (8) established that VATS lobectomy was less costly than lobectomy performed through a thoracotomy. However, their study also demonstrated that in spite of the increased cost associated with employing the robotic technology relative to VATS - only technique, robotic lobectomy was less costly than thoracotomy and lobectomy by almost $4,000 dollars. In our retrospective analysis of 176 robotic assisted lobectomies compared to 76 VATS lobectomies performed between 2005 to 2011, (presented at CRSA, 2012), lobectomies performed using the robotic-assisted approach described previously reduced direct cost by $560 dollars per case. The majority of cost saving occurred as a result of reduced length of hospital stay and lower overall nursing care cost.

Simply put, VATS pulmonary resection can be difficult to master even for some of the best thoracic surgeons, and has been predominantly utilized as an operative approach for early stage neoplastic disease. The limited adoption of the VATS technique has become the Achilles' heel of the VATS platform.

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