Editorial

Robotic lobectomy - the future of minimally invasive lobectomy?

Brian E. Louie

Co-Director, Minimally Invasive Thoracic Surgery Program, Swedish Cancer Institute and Medical Center, WA 98104, USA

Corresponding to: Brian E. Louie, MD, FRCSC, FACS. Swedish Cancer Institute and Medical Center, Suite 850, 1101 Madison Street, Seattle, WA 98104, USA. Email: brian.louie@swedish.org.

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It has been almost 20 years since the first reports of minimally invasive lobectomies appeared. Despite the tremendous amounts of research performed on VATS lobectomy showing its benefit over open thoracotomy, a mere 32% of all lobectomies are performed via this technique in the Society for Thoracic Surgeons database and only 6% in the Nationwide Inpatient Sample (1). So, why is it that in a recent review of clinical stage I lung cancers over 70% were still completed using open thoracotomy?(2). Advocates of an open approach still cite the ability to sample and perform a "more thorough" lymphadenectomy, the instability of the VATS platform and the lack of precision with the fissure-less-dissection VATS technique as reasons to maintain the status quo.

However, the introduction of robotic assisted lobectomy promises to address the concerns from open thoracotomy advocates (1,3-5) by allowing surgeons to have a stable platform to likely perform a lymphadenectomy similar to open thoracotomy with equal precision given the superior image, magnification and stability. Clearly many thoracic surgeons are interested as evidenced by the growth and plans by Intuitive Surgical makers of the da Vinci robotic surgery system. But, is all the hype true or is this all driven by the marketers trying to sell more robotic surgery systems? In a recent systematic review entitled, "A systematic review of meta-analysis on pulmonary resection by robotic video-assisted thoracic surgery" Cao and colleagues looked at a total of 941 patients in 12 institutions who had undergone robotic pulmonary resection (6). The results of this meta-analysis discuss and highlight the current issues surrounding pulmonary resection.

It is reasonable to conclude that at the current time, robotic pulmonary resection is relatively safe in expert centers; one notes however that of the 18 papers reviewed in this paper, 13 are from the same 6 authors. Perioperative mortality ranges from 0-3.8% which is similar to reported VATS lobectomy rates and consistent with open lobectomy for similar stage cancers. Conversions rates from robotic to open thoracotomy remain higher than anticipated with some reports showing a nearly 1 in 5 conversion rate. However, one must remember that these reported outcomes likely represent the first robotic cases for all authors. Until more experience and outcomes are reported from other academic and non-academic centers around the world the feasibility and safety outcomes apply only to experienced centers.

There is little comparative data where the outcomes of robotic lobectomy are directly compared to standard VATS or open lobectomy. Logic dictates that robotic lobectomy will be superior to open thoracotomy in terms of operative and clinical outcomes such as length of stay and blood loss, very much like VATS is to open surgery with these same parameters. In the meta-analysis, the one comparative paper by Jang *et al*. (7) showed what most experienced VATS surgeons would expect: that ultimately the operative outcomes are going to be similar in terms of length of stay, operative length, and blood loss when compared to at least 2 years of experience with VATS lobectomy. More recent publications are also confirming these findings but longer term studies are needed to prove the true benefits of robotic surgery (1).

Adoption and integration of robotic lobectomy into practice however, is going to depend upon more than similar operative outcomes in the era of cost constraint. Robotic lobectomy will have to show a survival and/or an oncologic benefit. Although some survival data is reported and similar to open or VATS cases, the next

several years are likely to see additional research using surrogate measures of oncologic effectiveness in robotic surgery since 5 year survival data is still maturing. When the rate of nodal upstaging is used as one of the measures, there appears to be some value in robotic lobectomy since upstage of clinical stage I cancers may be higher (21%) with robotic surgery (8) when compared to VATS (11.6%) or open (14.3%) (2).

At the current time, the benefit of robotic lobectomy is in increasing the number of minimally invasive lobectomies. However, that means open surgeons need to learn a new set of techniques, be successful at the technique and integrate the technique. Although the learning curve is estimated at about 20 cases, it's likely that this learning curve will be shorter for most surgeons with a more standardized approach, consistent proctoring and the educational platforms available to robotics, which are unique. There is little benefit in converting experienced VATS surgeons based on the current data of similar operative outcomes and they may wish to wait until additional data supporting robotic over VATS lobectomy is produced. The robotic platform may also encourage experienced VATS surgeons to expand the indications for a minimally invasive lobectomy (3).

Lastly and probably most contentious is the question on many surgeons tongues - what about the cost? This ultimately may be the key breaking point for robotic surgery since the institution has to have the funds to purchase and then operate the system. As expected, the United States leads all countries in terms of purchased and installed robotic surgery systems whereas Canada, Europe and Asia whose health systems are more centralized have fewer. Nary a robot is seen in the developing world.

Even with purchased and operational systems, cost and cost-effectiveness are front and center in most administrators' minds. The only cost analysis cited was performed using only 12 robotic cases and certainly does not reflect the current environment (9). The challenge in any study around cost will be the definitions of "cost" since there is no consistent methodology. Truthfully, this is probably best evaluated as part of a randomized trial comparing robotic lobectomy to VATS and open so that clinical outcomes and cost data are collected and analyzed prospectively.

Like Cao and colleagues concluded in their review, the current status of robotic surgery remains in the area of safety and feasibility. While experienced centers are reporting outcomes similar to historic controls, these results are from 6 authors. The generalizability to less experienced centers will require other centers to report their results. More data is required to determine the benefits of robotic lobectomy in terms of oncologic effectiveness and cost effectiveness. Fortunately, the future of robotic lobectomy appears to be bright and promising especially if the robotic research that has begun in several of these centers focusing on the key issues of oncologic effectiveness and cost effectiveness favors robotics.

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