Is the learning curve for video-assisted thoracoscopic lobectomy affected by prior experience in open lobectomy?

Sharon Okyere, Rizwan Attia*, Levon Toufektzian and Tom Routledge

Department of Cardiothoracic Surgery, Guy’s Hospital, London, UK

* Corresponding author. Department of Cardiothoracic Surgery, 6th Floor Tower Wing, Guy’s Hospital, London SE1 9RT, UK. Tel: +44-207-1880214; fax: +44-207-1881006; e-mail: rizwanattia@doctors.org.uk (R. Attia).

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Abstract

A best evidence topic was written according to a structured protocol. The question addressed is the learning curve for video-assisted thoracoscopic (VATS) lobectomy affected by prior experience in open lobectomy? Two hundred and two studies were identified of which seven presented the best evidence on the topic. The authors, date, journal, country of publication, study type, participating surgeon and relevant outcomes are tabulated. The studies presented discuss the learning experiences of surgeons with a range of proficiency in open lobectomy in performing VATS lobectomy. Four of the studies made direct comparisons between the outcomes achieved by trainees and fully qualified surgeons. Trainees performed a total of 154 VATS lobectomies and the consultants performed 714. The reported number of open lobectomies performed by trainees ranged 14–50. In one study, a qualified surgeon who had performed 100 open lobectomies achieved a statistically significant progression in his learning curve and was able to safely perform VATS lobectomies after 6 months. A trainee who had performed only 14 open lobectomies achieved a similar blood loss to his experienced supervisors (P = 0.79). Two trainee surgeons who had each performed at least 20 open lobectomies achieved similar mean intraoperative blood loss (P = 0.2) and complication rate (P = 0.4) to their experienced consultant when performing VATS lobectomy. Average duration of chest drainage was similar between consultant and trainee groups (P = 0.34) and was improved in favour of trainees in one group (P < 0.001); this might be due to the fact that they operated on more technically straightforward cases. Four trainee surgeons who had performed at least 50 open pulmonary resections each managed to achieve a similar mean operative time to their consultant in their first 46 cases, and a lower morbidity (26 vs 34.7%). There was no increase in mortality in the trainee groups. Surgeons with limited experience in open lobectomy can achieve good outcomes in VATS lobectomy comparable with their more experienced seniors.

Keywords: Lobectomy • Video assisted thoracoscopic surgery • Training • Learning • Experience

INTRODUCTION

A best evidence topic in cardiothoracic surgery was written according to a structured protocol. This is fully described in the ICVTS [1].

THREE-PART QUESTION

Is the [learning curve] for [video assisted thoracoscopic surgery] affected by prior experience in [open lobectomy]?

CLINICAL SCENARIO

You are a trainee placed with a senior surgeon who routinely performs video-assisted thoracoscopic (VATS) lobectomies. You have heard other trainees say that VATS lobectomy is harder to learn without a lot of prior experience in open lobectomy. You decide to review the literature to find out how prior experience in open lobectomy correlates with the VATS lobectomy learning curve and outcomes.

SEARCH STRATEGY


SEARCH OUTCOME

Two hundred and two results were returned and seven were selected as the best evidence on the topic (Table 1).
<table>
<thead>
<tr>
<th>Author, date, journal and country</th>
<th>Study type (level of evidence)</th>
<th>Study participants</th>
<th>Outcomes</th>
<th>Key results</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ra et al. (2012), Kor J Cardiovasc Surg, Korea [2]</td>
<td>Single-centre retrospective observational study (level IIb)</td>
<td>1 junior thoracic surgeon experienced in open lobectomy performed 38 pulmonary lobectomies (14 thoracotomy, 14 VATS, 10 conversions)</td>
<td>Change in procedure approach with experience</td>
<td>Change in procedure approach with experience: VATS Second quarter: 0 Third quarter: 5 Thoracotomy Third quarter: 6 Fourth quarter: 0 Conversion Second quarter: 5 Third quarter: 1 ($P = 0.002$)</td>
<td>Surgeon had performed 100 open lobectomies, assisted in 100 VATS lobectomies and was competent in minor VATS procedures After 6 months of experience, he was able to reliably perform VATS lobectomy with no operative mortality</td>
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<td>Ferguson et al. (2006), Eur J Cardiothorac Surg, UK [3]</td>
<td>Prospective observational study (level IIb)</td>
<td>1 established consultant-performing 230 VATS lobectomies 4 trainee surgeons performing 46 VATS lobectomies</td>
<td>Mean operating time</td>
<td>Consultant’s mean operating time: Group 1: 158 min Group 2: 139 min Group 3: 130 min Group 4: 136 min Group 5: 121 min ($P \leq 0.0001$) Trainees’ mean operating time: 160 min</td>
<td>Each of the trainees had performed at least 50 open lobectomies and other less complex VATS surgeries The consultant had no prior training in VATS lobectomy It is likely that the trainees’ mean operating time would have declined had they done more procedures</td>
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<td>Billé et al. (2013), Gen Thorac Cardiovasc Surg, UK [4]</td>
<td>Retrospective cohort study (level IIb)</td>
<td>Established cardiothoracic consultant performing 66/100 VATS lobectomies 2 inexperienced senior thoracic surgical trainees performing 34/100 VATS lobectomies</td>
<td>Mean operating time Intraoperative blood loss Conversion rate Postoperative complication rate</td>
<td>Group A: 125 ± 30 min Group B: 133 ± 26 min ($P = 0.18$) Group A: 200 ± 50 ml Group B: 250 ± 60 ml ($P = 0.2$) Group A: 9.1% Group B: 8.8% ($P = 0.6$) Group A: 36.3% Group B: 32.3% ($P = 0.4$)</td>
<td>The consultant had completed a fellowship in minimally invasive thoracic surgery, and performs 25 VATS lobectomies per year The trainees had performed at least 20 open lobectomies each and assisted/observed in 5–10 VATS lobectomies There was no statistical significance of any of the parameters used to compare the trainee and consultant groups</td>
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<td>Author, date, journal and country Study type (level of evidence)</td>
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<td>Konge et al. (2012), Interact CardioVasc Thorac Surg, Denmark [5] Single-centre prospective observational study (level IIIa)</td>
<td>1 inexperienced trainee surgeon performing 29 VATS lobectomies 2 experienced VATS surgeons performing 185 cases VATS lobectomies</td>
<td>1 month follow-up complication rate</td>
<td>Group A: 26.6% Group B: 41.2% ( (P = 0.1) )</td>
<td>A training programme in VATS lobectomy is feasible without compromising patient outcomes</td>
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<td></td>
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<td>Median time to drain removal</td>
<td>Group A: 3 days (range: 1–26) Group B: 3 days (range: 1–25) ( (P = 0.3) )</td>
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<td>Median length of hospital stay</td>
<td>Group A: 5.5 days (range: 2–96) Group B: 5 days (range: 3–20) ( (P = 0.5) )</td>
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<td>Zhao et al. (2010), World J Surg, China [6] Single-centre retrospective observational study (level IIIb)</td>
<td>1 surgeon experienced in other thoracoscopic procedures and open lobectomy performed 90 VATS lobectomies 3 operative groups according to chronology</td>
<td>Procedure duration</td>
<td>Trainee had longer operative time 120 min vs 100 min ( (P = 0.04) )</td>
<td>Trainee had performed only 14 open lobectomies before, but had performed minor VATS procedures and observed many VATS lobectomies Experience in open surgery is not a prerequisite for learning VATS lobectomies VATS training can be introduced early in the education of thoracic surgeons</td>
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<td>Perioperative bleeding</td>
<td>No difference in operative bleeding ( (P = 0.79) )</td>
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<td>Days with chest tube</td>
<td>Trainee had lower chest tube duration 1 vs 2 days ( (P &lt; 0.001) )</td>
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<td>Hospital stay</td>
<td>Trainee 3 vs 4 days ( (P &lt; 0.001) )</td>
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<td>Postoperative complications</td>
<td>79% patients had no complications, 2 had atrial fibrillation</td>
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<td>Wan et al. (2008), Gen Thorac Surg, China [7] Retrospective cohort study (level IIIb)</td>
<td>Consultants with 3 years of experiences in VATS major lung resections performed 51/111 lung resections</td>
<td>Conversion to thoracotomy for bleeding</td>
<td>Trainee group: 5% (3) Consultant group: 2% (1) ( (P = 0.39) )</td>
<td>The only significant difference between the consultant and trainee groups was operating time but this had no short-term impact on the patient outcomes VATS major lung resection can be safely taught to trainees under supervision of an experienced consultant</td>
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<td>Mean operating time</td>
<td>Trainee group: 162 min (range: 112–212) Consultant group: 136 min (range: 86.8–184) ( (P = 0.01) )</td>
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<td>Mean blood loss</td>
<td>Trainee group: 236 ml (range: 0–520) Consultant group: 302</td>
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</table>
RESULTS

Ra et al. [2] examined a single surgeon who had previously performed 100 open lobectomies. Thirty-eight lobectomies were performed (14 VATS, 14 open thoracotomy and 10 VATS conversions to open). There was an increase in the number of VATS lobectomies performed from the second to the third quarters of the study (0–5) and a decrease in the number of conversions (5–1). There was also a decrease in the number of open thoracotomies from the third quarter to the fourth quarter (6–0). The changes reflect a statistically significant progression of the surgeon on his learning curve (P = 0.002).

Ferguson et al. [3] evaluated 276 VATS resections. The results of 46 VATS lobectomies performed by 4 trainees who had performed ≥50 open pulmonary resections were compared with a consultant’s first 230 procedures. The consultant’s procedures were divided into five chronological groups of 46 (Groups 1–5). There were no significant differences in patient demographics and lung function between the groups. The consultant’s mean operating time declined significantly between the groups (P < 0.0001) as did blood loss (P = 0.0007). There was no significant difference in the mean operating time of the consultant and trainees in the first 46 cases; however, the trainees’ mean operating time was longer than that of the rest of the consultant’s cases (trainees vs Group 2: P = 0.0118; Group 3: P = 0.0003; Group 4: P = 0.0039; Group 5: P < 0.0001). Conversion to open thoracotomy was 30.4% for the consultant’s first cohort vs 6.5% for trainees (P = 0.08) with more blood loss compared with trainees (P = 0.0162). This is likely accounted for by the consultant’s experience in assisting the trainees and institutional learning curve being achieved. Overall mortality was <1% and morbidity was 34.7% in the consultant group vs 26% for trainees.

Billé et al. [4] reviewed 100 VATS lobectomies by an established consultant (>25 VATS lobectomies/year), and 2 trainees (>20 open lobectomies and assisted/observed 5–10 VATS lobectomies). The consultant performed 66 (Group A) and the trainees 34 (Group B). The consultant selected the trainees’ patients based on the clinical
staging, lymph node involvement, computed tomography anatomy and presence of adhesions. The groups were statistically similar in baseline characteristics with no differences in comorbidities (P = 0.48). Although not statistically significant, the operating time was longer for Group B (133 ± 26 vs 125 ± 30 min, P = 0.18); intraoperative blood loss was greater in Group B (250 ± 60 vs 200 ± 50 ml, P = 0.2). Group B had a shorter hospital stay (5 days [3–20] vs 5.5 days [2–96], P = 0.5). Postoperative complication rates were similar (Group A: 36.3% vs Group B: 32.3% P = 0.4).

Konge et al. [5] compared 29 VATS lobectomies by a junior trainee and 185 by two senior surgeons. The trainee had limited prior experience in open lobectomy (14 procedures). However, he performed 100 minor VATS procedures and observed 100 VATS lobectomies in preparation. Operating time for the trainee was significantly longer [median: 120 min (74–160) vs 100 min (42–255), P = 0.04]. There was no significant difference in perioperative bleeding [median 100 ml (10–500) vs 50 ml (5–2500), P = 0.79]. The chest tubes of trainees’ patients were removed earlier (median: 1 vs 2 days, P = 0.001) and hospital stay was shorter (median: 3 days vs 4 days, P < 0.001). Although the Spearman’s Rho value for the operative time and blood loss show a decline, there was no significant change in perioperative blood loss or procedure time as the trainee performed more operations (P = 0.42 and P = 0.64, respectively). None of the trainees’ procedures had to be converted to thoracotomy. Without much prior experience in open lobectomy, the trainee was able to produce results comparable with two VATS experts.

Zhao et al. [6] investigated the VATS learning curve of a surgeon who was experienced in VATS and open lobectomy. Ninety lobectomies were performed. The patients were divided into three chronological groups of 30 (Groups A, B and C). There were no demographic or clinicopathological differences between the groups. The operative time for Group A (214.2 min ± 62.2) was significantly longer than Groups B and C, which had similar operating times (153.8 min ± 30.1 and 148.3 min ± 31.8, P < 0.001 respectively). Patients in Group A (285 ml ± 152.1) also lost significantly more blood compared with patients in Groups B and C (150 ml ± 76.6 and 138.3 ml ± 79.5, P < 0.001). The percentage of conversions to open lobectomy increased from the first to the last group (3.3–6.7%, P = 0.781). There was no significant change in the length of hospital stay, chest tube duration, lymph node dissection or the rate of complications. According to the author, the learning curve plateau was achieved after 30 cases.

Wan et al. [7] compared 51/111 (46%) VATS lung resections performed by a senior surgeon vs 60/111 (54%) performed by trainees. Patient characteristics and risk factors were comparable between the groups. Conversion to thoracotomy for control of pulmonary artery bleeding occurred in 3 (5%) patients in the trainee group and 1 (2%) in the consultant (P = 0.39). Trainees’ mean operating time was significantly longer (162 min vs 136 min, P = 0.01). There was no significant difference in mean blood loss (P = 0.4); length of hospital stay (P = 0.4); duration of chest tube drainage (P = 0.9) or complications (P = 0.95). Overall mortality was 0%. The authors concluded that VATS major lung resection could be safely taught to trainees in a stepwise approach.

Reed et al. [8] compared outcomes in 97 open, 105 VATS lobectomies. There were no apparent differences in mortality, prolonged airleak, atrial fibrillation or other complications between the two groups. Stepwise approach to the incorporation of VATS lobectomies increased the operative competencies of the attending surgeon and enabled training of the residents and new attendings.

**CLINICAL BOTTOM LINE**

The learning curve for VATS lobectomy is not eliminated by prior experience in open lobectomy. Junior surgeons with less experience in open lobectomy are able to demonstrate similar outcomes and similar learning curves to their more experienced counterparts.

**Conflict of interest:** none declared.

**REFERENCES**


eComment. The wide spectrum of thoracic approaches on a learning curve basis

Authors: Eleftherios Spartalis, Christos Damaskos, Dimitrios Dimitroulis and Nikolaos Nikitas

2nd Department of Propedeutic Surgery, University of Athens, Medical School, Athens, Greece
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We read with great interest the article by Okyere et al. [1]. According to the Authors, and based on their thorough review of the literature, surgeons with limited experience in open lobectomy can achieve good outcomes in video-assisted thoracoscopic (VATS) lobectomy comparable to that of their more experienced seniors. This also means that the learning curve for VATS lobectomy is not eliminated by prior expertise in open surgery.

We would like to make it a further comparison of thoracic approaches and their learning curves, both for experienced open surgeons and novices, including robotic surgery.

In the field of abdominal surgery and especially in urology, where robotic prostatectomy has become the gold standard, experienced open surgeons can safely incorporate robotic procedures into practice and achieve outcomes comparable to fellowship-trained robotic surgeons quickly [2]. The advantage of using the robotic 3D camera in coordination with the instruments is that the vision is directed to the target tissue, bringing the instruments to address the target lesion from a straight perspective and obtaining similar angle of view as for open surgery [3].

And here is where controversy begins. Retrospective series indicate that robotic lobectomy, when performed by surgeons who were experienced with robotic surgery, has lower postoperative complication rates and a shorter hospital stay compared with open lobectomy [2]. We read with great interest the article by Okyere et al. [1]. According to the Authors, and based on their thorough review of the literature, surgeons with limited experience in open lobectomy can achieve good outcomes in video-assisted thoracoscopic (VATS) lobectomy comparable to that of their more experienced seniors. This also means that the learning curve for VATS lobectomy is not eliminated by prior expertise in open surgery.

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