

Video-assisted thoracoscopic surgery lobectomy at 20 years: a consensus statement

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Abstract

OBJECTIVE: Video-assisted thoracoscopic surgery (VATS) lobectomy has been gradually accepted as an alternative surgical approach to open thoracotomy for selected patients with non-small-cell lung cancer (NSCLC) over the past 20 years. The aim of this project was to standardize the perioperative management of VATS lobectomy patients through expert consensus and to provide insightful guidance to clinical practice.

METHODS: A panel of 55 experts on VATS lobectomy was identified by the Scientific Secretariat and the International Scientific Committee of the '20th Anniversary of VATS Lobectomy Conference—The Consensus Meeting'. The Delphi methodology consisting of two rounds of voting was implemented to facilitate the development of consensus. Results from the second-round voting formed the basis of the current Consensus Statement. Consensus was defined *a priori* as more than 50% agreement among the panel of experts. Clinical practice was deemed 'recommended' if 50–74% of the experts reached agreement and 'highly recommended' if 75% or more of the experts reached agreement.

RESULTS: Fifty VATS lobectomy experts (91%) from 16 countries completed both rounds of standardized questionnaires. No statistically significant differences in the responses between the two rounds of questioning were identified. Consensus was reached on 21 controversial points, outlining the current accepted definition of VATS lobectomy, its indications and contraindications, perioperative clinical management and recommendations for training and future research directions.

CONCLUSION: The present Consensus Statement represents a collective agreement among 50 international experts to establish a standardized practice of VATS lobectomy for the thoracic surgical community after 20 years of clinical experience.

Keywords: Video-assisted thoracoscopic surgery • Minimally invasive pulmonary resection • Lung resection • Non-small-cell lung cancer • Consensus

INTRODUCTION

Video-assisted thoracoscopic surgery (VATS) lobectomy for non-small-cell lung cancer (NSCLC) has made a major impact in thoracic surgery. Since the first procedure was performed 20 years ago, the operative approach and instrumentation have evolved gradually [1, 2]. In 2007, the Cancer and Leukemia Group B (CALGB) 39802 trial established the most authoritative and accepted definition of the VATS lobectomy technique: no use of rib-spreading; utility incision with a maximum length of 8 cm to deliver the specimen; individual dissection of the vein, arteries and airway for the lobe; standard lymph node sampling or dissection [3]. This definition described a procedure that would reduce surgical trauma, improve

surgical outcomes and adhere to recognized oncological principles, which were not established in earlier versions of the minimally invasive strategy [4, 5].

In recent years, a number of large institutional studies, multi-institutional registries and meta-analyses have demonstrated the perioperative safety and long-term oncological efficacy of VATS lobectomy for patients with early-stage NSCLC [6–9]. Data from national registries in the United States have demonstrated increasing proportions of lobectomies being performed by the VATS approach, particularly by general thoracic surgeons, who are more likely to perform complex noncardiac thoracic procedures [10, 11]. In the Society of Thoracic Surgeons General Thoracic Surgery Database, 45% of lobectomies were performed thoracoscopically

in 2010 [11]. In Denmark, more than half of all lobectomies are currently performed by VATS for NSCLC, while a recent multi-institutional database from China reported the outcomes of more than 1700 patients who underwent CALGB-defined VATS lobectomies [2, 12]. Despite this growing body of evidence, some scepticism remains within the thoracic oncology community regarding the VATS approach, as no randomized-controlled trials have been performed comparing the CALGB-defined VATS with open thoracotomy [1, 13]. In addition, there is a lack of conformity regarding the practice of VATS lobectomy in the current clinical setting. The aim of the current project was to standardize the perioperative management of VATS lobectomy patients through expert consensus and to provide insightful guidance to clinical practice.

METHODS

Consensus approach

The Delphi methodology facilitates the measurement and development of consensus among experts within a specialty [14, 15]. The main features of this technique include anonymity of participants to avoid individual dominance, an iterative process to allow changes of opinion in different rounds of questioning and controlled feedback for the participants by revealing group responses in the previous round of questioning. A number of studies have demonstrated the value of the Delphi method in areas of health care and epidemiology, particularly when robust forms of evidence such as randomized-controlled trials were unavailable [12, 16, 17].

Scientific boards

The '20th Anniversary of VATS Lobectomy Conference—The Consensus Meeting' was held in Edinburgh, UK, in November 2012. As part of the VATS Projects, the Collaborative Research (CORE) Group (Tristan D. Yan and Christopher Cao) conducted the consensus in conjunction with the International Scientific Committee (Tristan D. Yan, Thomas A. D'Amico, Todd L. Demmy, Jianxing He, Henrik Hansen, Scott J. Swanson and William S. Walker). The CORE Group performed the following tasks: (i) performing a systematic review of the medical literature on VATS lobectomy over the past 20 years; (ii) identifying the main conflicting arguments and (iii) preparing a list of possible solutions relating to these conflicting points and identifying the respective levels of clinical evidence supporting possible solutions. Based on the current clinical evidence, the International Scientific Committee created a list of pertinent consensus topics, which were formulated as multiple-choice questions. In total, 22 questions were selected to include participant demographic data ($n = 2$), VATS lobectomy definitions ($n = 1$), eligibilities for surgery ($n = 7$), perioperative management options ($n = 7$) and questions concerning the future training issues and research directions ($n = 5$).

Selection of panel of experts

To formulate the panel of experts, we performed a literature search using Pubmed supplemented by the Web of Science to identify institutions that have performed more than 100 VATS lobectomy procedures. We then contacted the chief surgeon who performed the operations. The email addresses of these participants were confirmed by CTSNet (<http://www.ctsnet.org/sections/members/surgeons/>). In addition, several authors who have published in high-

impact journals suggested by the International Scientific Committee were also included. Overall, a panel of 55 experts on VATS lobectomy were identified by the Scientific Secretariat to form the International VATS Lobectomy Consensus Group.

Delphi voting process

An individualized invitation was emailed to the panel of experts with a link to a secure website that presented 22 standardized questions. Delphi methodology consisted of two rounds of voting. The first round of voting took place on 15 September 2012. Anonymous responses to the questions in the first round were tabulated into a centralized database. The members of the panel of experts did not have access to the opinions of the other members during the first-round voting. The second-round voting was conducted on 15 October 2012. The experts reviewed their peers' selections, reflected on their own practices and then submitted their final recommendations to target the general thoracic surgical community. Results from the second-round voting formed the basis of the current Consensus Statement. Consensus was defined *a priori* as more than 50% agreement among the panel of experts [18]. The clinical practice was deemed 'recommended' if 50–74% of the experts reached agreement. The clinical practice was deemed 'highly recommended' if 75% or more of the experts reached agreement.

RESULTS

Demographic data

Fifty-one international experts (93%) in VATS lobectomy from 16 countries completed the first-round electronic questionnaire. Fifty (91%) completed the second-round questionnaire, representing the largest survey of its kind for minimally invasive surgical procedures to date. No statistically significant differences in responses between the two rounds of questioning were identified. Of the respondents who completed the second round questionnaire, 60% were from Europe, 20% were from North America, 16% were from Asia and 24% were from Australasia as seen in Figure 1. A summary of the experts' institutional case volume is presented in Figure 2. There was a relatively even distribution of surgical experience, represented by the total case volume among institutions. This minimized the possibility of the consensus being dominated by high-volume or low-volume centres.

Definition of VATS lobectomy

Regarding the CALGB definition of VATS lobectomy as 'no use of rib-spreading; a maximum length of 8 cm for the utility incision; individual dissection of pulmonary vessels and bronchus; standard node sampling or dissection', an expert consensus was reached. Forty-one respondents (82%, 'highly recommended') completely agreed with the CALGB definition, while nine respondents (18%) stated that a small retractor should be acceptable in selected circumstances, such as conducting complex procedures (e.g. sleeve resection) or delivery of a large specimen.

Eligibility for VATS lobectomy

A summary of responses regarding the indications and contraindications for VATS lobectomy is presented in Table 1. Consensus was

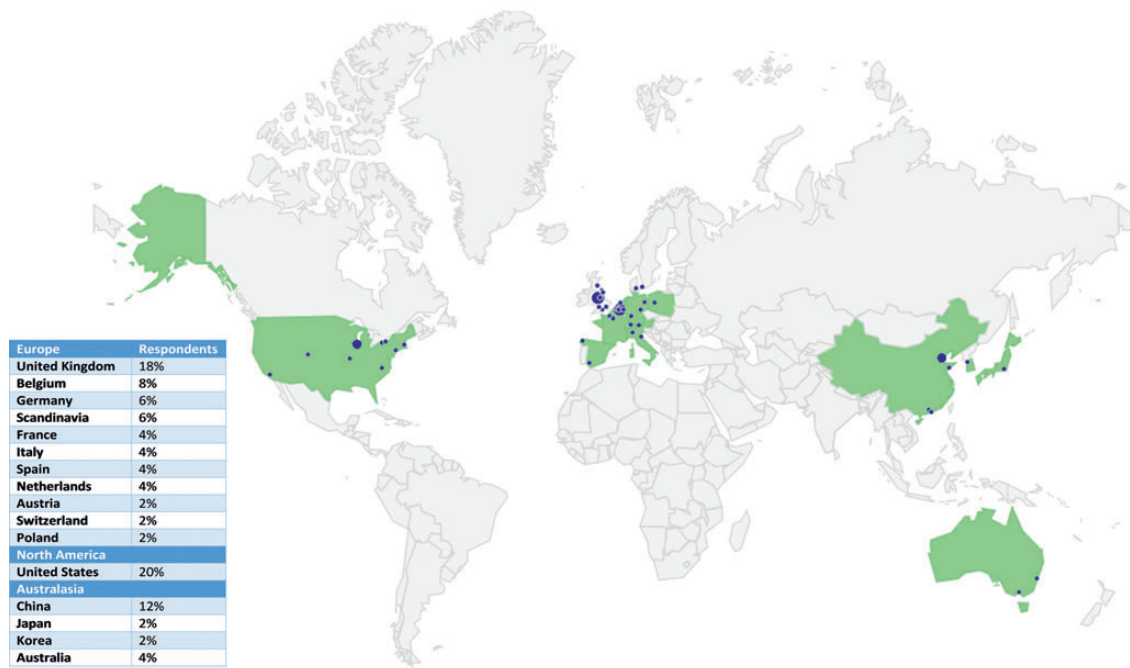


Figure 1: Summary of demographic data of panel of experts responding to the VATS lobectomy Consensus Statement questionnaire.

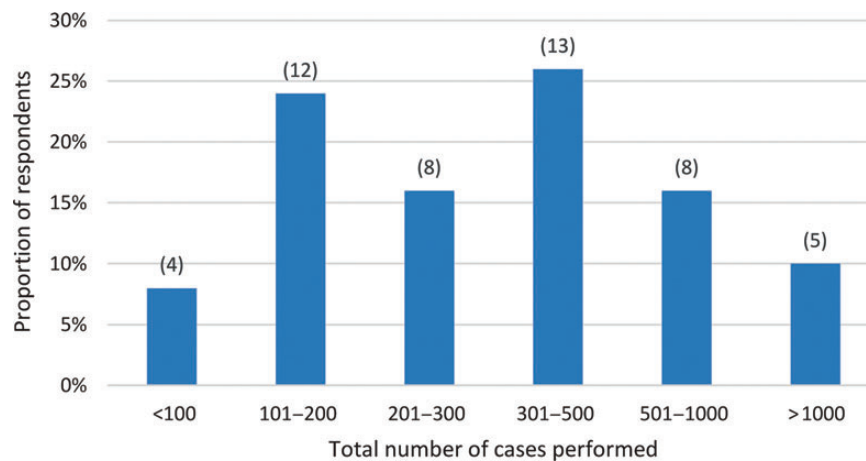


Figure 2: Bar graph demonstrating an even distribution of surgical experience among the participating experts' institutions.

reached on the following points: VATS lobectomy (i) is indicated for tumour size ≤ 7 cm (62%, 'recommended'); (ii) is indicated for N0/N1 disease (56%, 'recommended'); (iii) is contraindicated for chest wall involvement if tumour invades rib(s) (62%, 'recommended'); (iv) is relatively contraindicated if tumour invades hilar structures (64%, 'recommended'); (v) is not contraindicated in patients who had previous thoracic surgery and/or pleurisy (80%, 'highly recommended'); (vi) is contraindicated if FEV1 is $<30\%$ (76%, 'highly recommended') and (vii) is contraindicated if DLCO is $<30\%$ (64%, 'recommended').

Perioperative management

A summary of responses related to preoperative assessment, operative technique and postoperative management of VATS lobectomy patients is presented in Table 2. Consensus was reached on the following points: (i) preoperative PET/CT should be routinely

performed, with pathological assessment of enlarged (≥ 1 cm) or PET-positive mediastinal lymph nodes (80%, 'highly recommended'); (ii) EBUS/EUS is an acceptable approach for mediastinal lymph node assessment (60%, 'recommended'); (iii) initial assessment or exploration using VATS should be considered routinely prior to surgical resection (76%, 'highly recommended'); (iv) total ipsilateral systematic lymph node dissection is the most appropriate management of mediastinal lymph node (66%, 'recommended'); (v) total ipsilateral lymph node dissection should be performed for all patients undergoing VATS lobectomy (66%, 'recommended') and (vi) VATS lobectomy should be converted to open thoracotomy under the following circumstances: bronchial sleeve (54%, 'recommended'), vascular sleeve (96%, 'highly recommended'), bronchial-vascular sleeve (96%, 'highly recommended'), major bleeding (92%, 'highly recommended') and chest wall invasion by tumour (60%, 'recommended'). No consensus was reached on postoperative local-regional pain management strategies.

Table 1: Summary of responses regarding the indications and contraindications to VATS lobectomy from the panel of international VATS experts

Indications and contraindications for VATS lobectomy	Number of respondents (%)
T status for tumour	
≤5 cm (T1 and T2a)	16 (32)
≤7 cm (T1, T2a and T2b)	31 (64)
None of above	3 (6)
N status for tumour	
N0 only	1 (2)
N0 + N1	28 (56)
N0 + N1 + N2	21 (42)
Chest wall involvement is	
A contraindication if involving parietal pleura	3 (6)
A contraindication if involving rib(s)	31 (62)
Not a contraindication for VATS lobectomy	16 (32)
Centrality of tumour is	
An absolute contraindication if invading hilar structure(s)	12 (24)
A relative contraindication if invading hilar structure(s)	32 (64)
Not a contraindication	6 (12)
Previous thoracic surgery/pleurisy is	
An absolute contraindication	0
A relative contraindication	10 (20)
Not a contraindication	40 (80)
VATS lobectomy is contraindicated if FEV1 is	
<80% predicted	0
<70% predicted	1 (2)
<60% predicted	0
<50% predicted	5 (10)
<40% predicted	6 (12)
<30% predicted	38 (76)
VATS lobectomy is contraindicated if DLCO is	
<80% predicted	0
<70% predicted	0
<60% predicted	0
<50% predicted	8 (16)
<40% predicted	10 (20)
<30% predicted	32 (64)

Training and future directions

Concerning a number of important issues related to competence and training, consensus was reached on the following points: (i) 50 cases are required for VATS lobectomy technical proficiency (78%, 'highly recommended'); (ii) 50 annual resident cases are required for a VATS lobectomy training centre (52%, 'recommended'); (iii) thoracic surgeons should perform at least 20 cases annually to maintain VATS lobectomy operative skills (62%, 'recommended') and (iv) surgeons should be proctored while initiating a VATS lobectomy programme (100%, 'highly recommended') (Table 3).

Regarding the future directions, consensus was reached for VATS lobectomy to be incorporated into training programmes for surgical trainees with a special interest in thoracic surgery (94%, 'highly recommended') and standardized international surgical workshops should be made available to enhance the training of thoracic surgeons interested in commencing VATS lobectomy programmes (92%, 'highly recommended'). Furthermore, to establish more robust

Table 2: Summary of responses regarding perioperative management of VATS lobectomy procedures from the panel of international VATS experts

Perioperative management of VATS lobectomy	Number of respondents (%)
Preoperative investigation for N-status should include	
PET/CT and sampling of positive mediastinal lymph nodes	40 (80)
PET/CT and routine sampling of mediastinal lymph nodes	9 (18)
PET/CT only	1 (2)
Your preferred approach to sample mediastinal lymph nodes	
EBUS/EUS	30 (60)
Mediastinoscopy	18 (36)
VAMLA	1 (2)
I do not sample lymph nodes preoperatively	1 (2)
Would you undertake VATS assessment routinely at the time of surgical resection?	
Yes	38 (76)
No	12 (24)
The most appropriate management of mediastinal lymph nodes is:	
Total ipsilateral lymph node dissection	33 (66)
Lobe specific lymph node dissection	6 (12)
Systematic lymph node sampling	11 (22)
Lobe specific sampling	0
Random/no sampling	0
Which group(s) would you recommend to have total ipsilateral lymph node dissection? ^a	
All patients	33 (66)
Central tumour	13 (26)
Patients unfit for adjuvant chemotherapy or radiotherapy	5 (10)
N1-positive disease	15 (30)
N2-positive disease	14 (28)
None of above	1 (2)
Under which of the following clinical situation(s), would you recommend conversion to open thoracotomy? ^a	
Pneumonectomy	17 (34)
Bronchial sleeve	27 (54)
Vascular sleeve	48 (96)
Broncho-vascular sleeve	48 (96)
Pleural adhesions	2 (4)
Absence of fissure	1 (2)
Poor lung deflation	12 (24)
Major bleeding	46 (92)
Broncho-pleural fistula	18 (36)
Chest wall involvement	30 (60)
Operating theatre time pressure	2 (4)
None of above	0
Your preferred loco-regional postoperative pain management is	
PCA only	6 (12)
Epidural	17 (34)
Paravertebral	10 (20)
Intercostal nerve block	17 (34)
Others	0

^aMore than one answer option allowed.

clinical evidence, it is necessary to create a standardized international multi-institutional database (66%, 'recommended'). Fourteen experts (27%) believed it is necessary to perform a randomized-controlled trial to compare CALGB-defined VATS lobectomy with the open thoracotomy approach for patients with NSCLC (Table 3).

Table 3: Summary of responses regarding VATS lobectomy training and future of VATS lobectomy research from the panel of international VATS experts

VATS lobectomy training	Number of respondents (%)
How many cases are required to overcome the learning curve?	
25	10 (20)
50	39 (78)
75	0
>100	1 (2)
What is the minimum resident case volume that defines a training centre?	
>30 cases per year	24 (48)
>50 cases per year	26 (52)
How many cases should a surgeon perform to maintain his/her VATS lobectomy operative skills?	
20 cases per year	31 (62)
40 cases per year	19 (38)
≥60 cases per year	0
Should a surgeon be proctored prior to commencing a VATS lobectomy program?	
Yes	50 (100)
No	0
Regarding the future direction in this field, please choose from the following options: ^a	
I think that it is necessary to perform a RCT comparing CALGB-defined VATS lobectomy vs open thoracotomy	14 (27)
I think that it is necessary to establish multi-institutional databases, containing complete VATS lobectomy as a treatment approach	35 (67)
I think that more standardized surgical mentoring courses and/or programmes should be made available on a regular basis in different regions of the world in order to popularize VATS lobectomy approach	40 (77)
I think that VATS lobectomy should be incorporated into the current training programmes for all cardiothoracic trainees	23 (44)
I think that VATS lobectomy should be incorporated into the current training programmes for trainees intending to specialize/ have a major interest in thoracic surgery	43 (83)

^aMore than one answer option allowed

DISCUSSION

Potential perioperative benefits of the VATS approach compared with open thoracotomy include reduced incidences of prolonged air leaks, arrhythmias, pneumonia, pain and decreased inflammatory markers. The reduced postoperative complications combined with a significantly shorter duration of hospitalization have contributed to the increased cost-effectiveness of the VATS procedure [16, 19–21]. Long-term outcomes such as overall mortality and disease recurrence have also been shown to be similar or superior for patients who underwent VATS lobectomy compared with conventional open thoracotomy [6]. However, it is estimated that VATS lobectomy currently accounts for less than a third of all lobectomy procedures performed internationally, and variations in techniques exist among institutions. The present Consensus Statement aimed to standardize the perioperative management strategies of the VATS lobectomy and provide practical clinical guidance to general thoracic surgeons who are performing or interested in this procedure.

The Delphi technique is a useful qualitative tool to assess and establish consensus among a panel of experts by conducting repeated rounds of anonymous questionnaires [18]. The present project involved 50 international experts who represented institutions with considerable experience in performing VATS lobectomy procedures around the world. One of the most important potential limitations of the Delphi methodology relates to the possible poor response rate, which has been reported to be as low as less than 10% [15, 22]. It was encouraging that a relatively high response rate was achieved in the present project, with more than 90% of selected experts completing both rounds of the standardized survey. This may be a reflection of the overwhelming

interest from the participating experts in this timely and important report, which marked the milestone of 20 years since the inception of the VATS lobectomy procedure. In addition, the effective use of reminder emails may have also contributed to the relatively high response rate.

The key recommendations derived from the present Consensus Statement are presented in Table 4. There was overwhelming agreement among the panel of experts on the CALGB definition of VATS lobectomy, which signified the global acceptance of a standardized technique [3]. According to the Consensus Group, eligibility for VATS lobectomy should include tumour size ≤7 cm and N0 or N1 status. Chest wall involvement of rib(s) was considered a contraindication for VATS lobectomy, while centrality of tumour was considered a relative contraindication when invading hilar structure(s). Relatively poor FEV1 (30–60% predicted) or DLCO (30–60% predicted) independently was not considered to be a contraindication for VATS lobectomy. However, the panel of experts strongly advised caution for patients with extremely poor pulmonary function, particularly when FEV1 and DLCO were <30% of the predicted value. Nonetheless, there is evidence to suggest that eligible surgical candidates with NSCLC and limited pulmonary reserve may benefit more from the VATS approach than open thoracotomy [11]. The Consensus Group recommended routine preoperative PET/CT scanning and pathological assessment of positive or enlarged (≥1 cm) mediastinal lymph nodes, and the most appropriate management for lymph nodes was considered to be complete ipsilateral dissection in all patients. This recommendation will likely standardize the lymph node management approach, increase the staging accuracy and reduce the controversy related to the oncological efficacy of VATS lobectomy.

Table 4: Summary of recommendations derived from the Consensus Statement

VATS Lobectomy Consensus Recommendations

Indications for VATS lobectomy	
≤7 cm (T1, T2a and T2b)	Recommended
N0 or N1 status	Recommended
Contraindications for VATS lobectomy	
Chest wall involvement including rib(s)	Recommended
Centrality of tumour if invading hilar structure(s)	Recommended
Previous thoracic surgery or pleurisy is not a contraindication	Highly Recommended
FEV1 <30%	Recommended
DLCO <30%	Recommended
Preoperative Investigations	
PET/CT and sampling of positive mediastinal lymph nodes	Highly recommended
Sampling of positive lymph nodes by EBUS/EUS	Recommended
VATS assessment at the time of surgery	Highly recommended
Total ipsilateral lymph node dissection in all patients	Recommended
Indications for conversion to open thoracotomy	
Major bleeding	Highly recommended
Significant chest wall involvement	Recommended
Vascular sleeve	Highly recommended
Bronchial sleeve	Highly recommended
Broncho-vascular sleeve	Highly recommended
Training	
Number of cases to overcome steep learning curve: 50	Highly recommended
Resident case volume of a training centre: >50/year	Recommended
Minimum case volume to maintain VATS skills: >20/year	Recommended
Proctoring should be necessary in all new VATS surgeons	Highly recommended
Future directions	
Establishment of multi-institutional database	Recommended
Increased exposure of VATS lobectomy to trainees	Highly recommended
Establishment of standardized VATS lobectomy workshops	Highly recommended

The Consensus Group acknowledged the limitations of VATS lobectomy based on their individual experiences, with a collective recommendation to convert to open thoracotomy in cases of major bleeding, significant tumour chest wall involvement and the need for bronchial and/or vascular sleeve procedures. However, these recommendations are directed at the general thoracic surgical community, and indications for VATS lobectomy and conversion to thoracotomy may change as a surgeon gains more technical experience. The Consensus Group agreed that at least 50 cases should be performed by a surgeon to gain adequate technical proficiency and at least 20 cases should be performed annually to maintain his/her operative skills. There was strong agreement among the panel members to increase the exposure of VATS lobectomy for thoracic surgical trainees and to create standardized workshops for surgeons with an interest in performing VATS lobectomies.

An interesting observation regarding the future of VATS lobectomy was the relatively low proportion of participants who valued the necessity of performing a randomized-controlled trial comparing CALGB-defined VATS lobectomy with open thoracotomy for early-stage NSCLC. This issue was discussed extensively at the '20th Anniversary VATS Lobectomy Conference—The Consensus Meeting' and several potential reasons may explain this finding. Firstly, many VATS lobectomy surgeons expressed a lack of equipoise and stressed the benefits of VATS over open thoracotomy for patients who are eligible for both procedures. Secondly, there may be a significant challenge to identify surgeons who are proficient in both VATS lobectomy and open thoracotomy and willing

to randomise patients. Thirdly, the logistic difficulties of recruiting sufficient numbers of patients to identify small differences in long-term outcomes are also of major concern. However, these challenges do not justify against randomization and the Consensus Group actively encourages the development of high-level evidence from the international thoracic community in the future.

COMMENT

The present Consensus Statement represents a collective agreement among 50 international experts and institutions from 16 countries, outlining the current definition of the VATS lobectomy and its indications and contraindications, as well as perioperative clinical recommendations. Focus of VATS lobectomy in the near future should be directed on the establishment of international multi-institutional databases and the creation of mentoring workshops and standardized training programmes to progressively develop this technique widely among thoracic surgical trainees and specialists.

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