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Papers

Video assisted thoracic surgery for treatment of pneumothorax and lung resections: systematic review of randomised clinical trials

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Abstract

Objectives To determine if video assisted thoracic surgery is associated with better clinical outcomes than thoracotomy for three common procedures: surgery for pneumothorax, minor resections, and lobectomy.
Design Systematic review of randomised clinical trials.
Data sources Medline, Embase, Cochrane database of systematic reviews, Cochrane controlled trials register. Reference lists of relevant articles and reviews.
Methods Criteria for inclusion were random allocation of patients and no concurrent use of another experimental medication or device. At least two authors performed and confirmed data abstraction and analyses. Information on quality of trials, demographics, frequency of the events, and numbers randomised were collected.
Results 12 trials randomised 670 patients. Video assisted thoracic surgery was associated with shorter length of stay (reduction ranged from 1.0 to 4.2 days) and less pain or use of pain medication than thoracotomy in the five out of seven trials in which the technique was used for pneumothorax or minor lung resection. In the treatment of pneumothorax, video assisted thoracic surgery was associated with substantially fewer recurrences than pleural drainage in two trials (from 20 to 53 events prevented per 100 treated patients). No substantial advantages were observed for video assisted thoracic surgery in lobectomies.
Conclusions Video assisted thoracic surgery is associated with better outcomes and seems to have a complication profile comparable with that of thoracotomy for the treatment of pneumothorax and minor resections. As for lobectomy, further studies are needed to determine how it compares with thoracotomy.

Introduction

Thoracoscopy by direct vision (crouching and peering through an inadequate instrument) has been possible for many years but two developments opened the way to its wider application in the diagnosis and treatment of lung disease: the development of television cameras that displayed on large television screens a brilliantly lit and magnified view of the inside of the chest and the manufacture of a range of stapling and cutting devices for operating through ports of a centimetre or less in diameter. The newly developed term of video assisted thoracic surgery (VATS) was rapidly popularised. It was assumed that if patients could be managed with "keyhole" surgery rather than thoracotomy they would experience less pain and shorter hospital stays.[1] Lung biopsies for parenchymal lung disease or excision biopsies at the lung edge can readily be performed for diagnostic purposes. Virtually all operations for pneumothorax can be performed by video assisted thoracic surgery, and clinical experience is that it makes inspection and biopsy of the pleura easier. Formal anatomical lobectomy for the resection of lung cancer is more challenging.

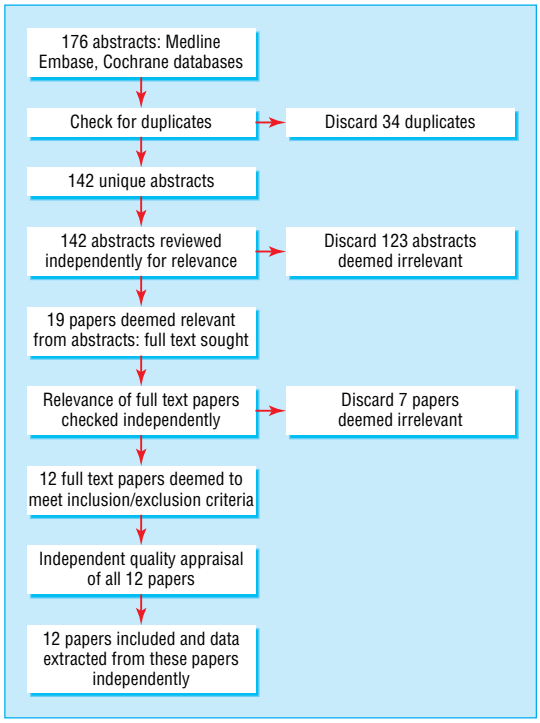
The relative advantages compared with open surgery through thoracotomy have not been assessed in a systematic review of the evidence from randomised trials. Without this evidence it is not possible to make recommendations for best practice or to provide guidance for its wider application. We carried out a systematic review of randomised clinical trials to determine if video assisted thoracic surgery is associated with better clinical outcomes than thoracotomy for three common thoracic procedures: surgery for pneumothorax, minor resections (wedge and segmental resections), and lobectomy.

Methods

We included only randomised clinical trials that compared video assisted thoracic surgery with conventional surgery. Our inclusion criteria were random allocation of patients, enrolment of general thoracic surgery patients, and no concurrent use of another experimental medication or device. We included in the review any trial of video assisted thoracic surgery applicable to our topics of interest.

Randomised trials were identified by searching Medline, Embase, Cochrane database of systematic reviews, and the Cochrane controlled trials register from 1980 to 2003. Only studies in humans were considered, and no language restrictions were applied. We used MeSH terms "thoracic surgery, video assisted" "thoracoscopy" and various combinations of text words that might be related to this specific procedure. A standard randomised controlled trial filter designed by the Cochrane collaboration for identifying trials was used for Medline and Embase (adapted from Scottish Intercollegiate Guideline Network (www.sign.ac.uk/methodology/filters.html)). We also searched the reference lists of randomised trials and reviews to look for additional studies.

We identified 142 unique abstracts. Independent review of these abstracts identified 12 unique studies meeting all inclusion criteria (figure). For each trial, we abstracted data on the number of patients randomised and the frequency of the events in the intervention (video assisted thoracic surgery) and control groups. One of the authors (AS) abstracted the data and another (JL) independently confirmed the counts of events and number of patients randomised to treatment groups. All authors participated in adjudication of any discrepancies.



Selection of papers for inclusion

For each trial, we collected data on outcomes such as recurrence of disease or failure (for pneumothorax surgery only), surgery time, measurement of pain and medication for pain, complications (any major), length of hospital stay, and costs. We also collected information on age, sex, and malignancy. We could not carry out meta-analysis because of the qualitative diversity of the outcomes and reported estimates.

We evaluated methodological quality of included studies using modified Jadad criteria,[2] which were based on study description, randomisation procedure, concealment of allocation, and dropouts and intention to treat analysis. Blinding was not applicable.

Results

Pneumothorax surgery—Six trials compared video assisted thoracic surgery with conventional methods in 327 patients. In four studies video assisted thoracic surgery was compared with conventional thoracotomy and in two studies with pleural drainage. In the trials that reported this information the average age of participants was 34 years and 27% were women (table 1). Three trials reported the method of randomisation, and one study had a significant imbalance in the number of patients assigned in each group.[3] All studies reported a reduced need for pain medication and three studies[4–6] reported significantly shorter hospital stays in patients in the intervention group (table 2). While Waller et al[7] and Ayed et al[6] reported more recurrences of pneumothorax in patients in the video assisted thoracic surgery group compared with thoracotomy group (6 *v* 2 and 3 *v* 0), Sekine et al reported three more cases of lung atelectasis (5 *v* 2) for patients in the thoracotomy group compared with patients in the video assisted thoracic surgery group.[8] Two studies that compared video assisted thoracic surgery with pleural drainage reported substantially fewer recurrences of pneumothorax in the intervention group (0 *v* 8 in Abdala et al[5] and 1 *v* 10 in Tschopp et al[3]).

Minor resection—Three randomised studies that compared video assisted thoracic surgery with conventional thoracotomy enrolled 147 patients.[9–11] The average age was 50 years (in three trials) and 61% were women (in two trials). All three trials reported information about the method of randomisation, and two received the highest quality score.[9 11] In two studies video assisted thoracic surgery was associated with reduced need for pain medication, shorter surgery time, and shorter length of stay.[9 10] In the third study there were no differences with regard to all outcomes of interest, and video assisted thoracic surgery was associated with higher costs (over $C1000 (£431, $774, €632) more) (table 2).[11]

Lobectomy—Three trials looked at video assisted lobectomy and conventional lobectomy in 196 patients. The average age of patients in these studies was 63 years and 49% were women. None of the studies reported information on method of randomisation, and in two studies analysis was not based on intention to treat.[12 13] Sugi et al found no difference in survival after video assisted thoracic surgery versus conventional surgery

Table 1 Characteristics of the randomised trials of video assisted thoracic surgery and conventional strategy

Study	Randomisation	Description of randomisation	Allocation concealment	Intention to treat	Mean age (years)	% Female	% With malignancy
Pneumothorax surgery							
Ayed 2000[6]	Randomised	Sealed envelope	Not clear	Yes	27	NR	NR
Sekine 1999[8]	Randomised	Not described	NR	Not clear	32	34	0
Waller 1994[7]	Randomised	Sealed envelope	Concealed	Yes	47	18	0
Gebhard 1996[4]	Randomly allocated	Not described	NR	Not clear	NR	NR	NR
Abdala 2001[5]	Randomly assigned	Not described	NR	Yes	NR	NR	NR
Tschopp 2002[3]	Randomised	Sealed envelope	NR	Yes	28	29	NR
Wedge/segment resection							
Santambrogio 1995[9]	Randomised	Computerised, randomised block design	NR	Yes	57	78	24
Ayed 2000[10]	Randomised	Sealed envelope	Not concealed	Yes	38	NR	16
Miller 2000[11]	Randomised	Computerised, randomised block design	Concealed	Yes	56	43	7
Lobectomy							
Sugi 2000[12]	Randomised	Not described	NR	No	65	43	100
Craig 2001[14]	Randomised	Not described	Concealed	Yes	63	46	87
Kirby 1995[13]	Randomised	Not described	Concealed	No	60	57	100

NR=not reported.

Table 2 Outcomes reported in the randomised trials of video assisted thoracic surgery (VATS) and conventional strategy

Surgical group comparison	No of people	Recurrence or failure	Surgery time (min)*	Length of stay (days)*	Pain/medication use	Other complications	Costs
VATS pneumothorax *v* **thoracotomy**							
Ayed 2000[6]	30/30	3 *v* 0	77 (SD 14) *v* 95 (SD 16)†	Mean 6.5 *v* 10.7†	Demerol 67 mg (SD 27) *v* 148 mg (SD 24)†	0/0	NR
Sekine 1999[8]	20/18	NR	NR	NR	Diclofenac 8 *v* 16†	Atelectasis 2 *v* 5	NR
Waller 1994[7]	30/30	6 *v* 2	45 (20-105) *v* 37 (24-60)†	4 (1-20) *v* 5 (3-30)	Morphine 25 mg (6-65) *v* 34 mg (10-60)	NR	NR
Gebhard 1996[4]	10/11	NR	49 (40-54) *v* 58 (45-70)†	5 (4-8) *v* 7 (6-9)†	Piritramide/person 1 (0-1) *v* 3 (2-4)†	NR	NR
VATS pneumothorax *v* pleural drainage							
Abdala 2001[5]	25/15	0 *v* 8†	NR	Mean 5.3 *v* 7.5†	Analgesics for 38 hours (SD 13) *v* 77 hours (SD 31)†	Air leak 0 *v* 6†	$1730 *v* $850‡
Tschopp 2002[3]	61/47	1 *v* 10†	NR	8.0 (SD 3.6) *v* 7.4 (SD 3.9)	Opioids 48 *v* 25†	Long term recurrence 3/59 *v* 16/47†	€1461 (SD 635) *v* €1080 (SD 455)‡
VATS wedge/segment *v* thoracotomy							
Santambrogio 1995[9]	22/22	NR	97 (SD 33) *v* 130 (SD 14)	4.6 (SD 1.1) *v* 7.8 (SD 0.9)†	Pain score 26 (SD 12) *v* 48 (SD 13)†; ketorolac 106 mg (SD 16) *v* 143 mg (SD 26)†	0/0	NR
Ayed 2000[10]	32/29	NR	45 (25-90)† *v* 60 (45-70)	3 (2-7) *v* 5 (4-7)†	Demerol 75 mg (45-150) *v* 150 mg (40-300)†	Respiratory 3 *v* 6	NR
Miller 2000[11]	20/22	NR	40 (30) *v* 37 (15)	3.2 (SD 3.4) *v* 2.9 (SD 2.3)	Morphine 51 mg (SD 27) *v* 52 mg (SD 26)	Any major 4 *v* 4	VATS costs $C1000‡ more
VATS lobectomy *v* thoracotomy							
Sugi 2000[12]	48/52	NR	NR	NR	NR	No survival difference between groups	NR
Craig 2001[14]	22/19	NR	141 (SD 39) *v* 121 (SD 31)	8.6 (SD 3.0) *v* 7.9 (SD 3.2)	NR	2 *v* 4	NR
Kirby 1995[13]	25/30	NR	161 (61) *v* 175 (93)	7.1 (SD 5.5) *v* 8.3 (SD 5.7)	Disabling pain 1 *v* 2	Mostly air leaks 6 v 19†	NR

NR=not reported.
*Mean (SD) or median (range) for surgery time, length of stay, and pain/medication use unless specified otherwise.
†Significant difference (P<0.05).
‡In September 2004, £1=$1.80, €1.48, $C2.32.

for lung cancer (90% *v* 93% at three years and 90% *v* 85% at five years).[12] Two other studies[13 14] reported information on outcomes of interest and found no substantial differences between the groups except for fewer air leaks found in the study by Kirby et al[13] (table 2).

Discussion

Evidence found in trials

Evidence from randomised controlled trials for benefits associated with video assisted thoracic surgery seems to be similar for pneumothorax and minor resections. Most studies reported reduction in the surgery time, use of pain medication, and length of hospital stay. Although in two trials more recurrences of pneumothorax were observed with video assisted thoracic surgery than with thoracotomy,[6 7] these studies were probably conducted relatively early in the development of the technique in individual centres. As surgeons become more experienced fewer complications are expected to occur, and these few events related to the "learning curve" should not serve as a justification for underuse of video assisted surgery in thoracic surgical units.

Experience with video assisted surgery in large series

Although the evidence for benefits and disadvantages associated with video assisted thoracic surgery compared with thoracotomy or pleural drainage (for pneumothorax surgery only) was limited to randomised controlled trials, it is consistent with and substantiates the findings of relatively large cohort studies. In pneumothorax surgery, one recent multicentre cohort study reported successful video assisted thoracic surgery for pneumothorax in 714 patients over a period of two years.[15] Another study based on 156 patients reported low morbidity and short length of hospital stay (mean of 2.4 days) associated with video assisted thoracic surgery.[16] Further Hatz et al reported excellent short and long term results comparable with thoracotomy.[17]

Minor resections with video assisted thoracic surgery were performed for solitary pulmonary nodules in malignant and non-malignant disease in two cohort studies.[18 19] Despite 49% of patients having malignant disease, successful diagnosis of the condition was possible in all cases and conversion to thoracotomy was necessary in only 16% of patients.[19]

Video assisted thoracic lobectomy is technically a much greater challenge and uptake has been slower. Some cohort studies report fewer conversions from video assisted thoracic surgery to conventional thoracotomy[20 21] and satisfactory long term results, particularly in patients with stage IA disease (T1N0M0).[12 20] However, evidence from randomised controlled trials for benefits associated with video assisted thoracic surgery for lobectomy was controversial, with no studies reporting substantial advantage. While Kirby and colleagues did report fewer air leaks and complications associated with video assisted thoracic surgery, they acknowledged that performing a major resection in what is essentially a closed chest is still a major concern among surgeons. These authors also found no short term advantages associated with video assisted thoracic surgery and no technical problems such as not routinely being able to perform node dissection.[13]

Costs of video assisted surgery

Three randomised controlled trials found higher costs associated with video assisted thoracic surgery; two of the trials[3 5] showed higher operating room costs compared with pleural drainage (not thoracotomy), but after savings due to fewer complications and reduced length of stay were considered, no difference was observed. The third trial, by Miller et al, reported higher

What is already known on this topic

Video assisted thoracic surgery can be used in the diagnosis and treatment of lung disease

It is not known whether this minimally invasive approach has any advantage over traditional thoracotomy

What this study adds

Video assisted thoracic surgery is associated with reduced length of hospital stay and reduced pain or use of medication in pneumothorax and minor resection surgery

It is also associated with substantial advantages compared with pleural drainage alone in the treatment of pneumothorax

No advantages were found for the use of video assisted thoracic surgery in lobectomies

costs associated with video assisted minor resections than with conventional thoracotomy.[11] Some other investigators reported higher operative costs associated with such minor resections.[22] However, the latter investigators also determined that video assisted thoracic surgery did save on costs after they considered reduced length of stay and fewer complications. Thus, it is likely that the cost differences in the study by Miller et al reflect different medical and surgical patients in this study (diagnosis of interstitial disease rather than resection of solitary or multiple nodules) and management practices specific to this Canadian centre.[11]

Conclusions

Video assisted thoracic surgery is associated with shorter length of hospital stay and less pain or use of pain medication than thoracotomy in the treatment of pneumothorax and minor resections. In the treatment of pneumothorax video assisted thoracic surgery is superior to pleural drainage and seems to have a complication profile comparable with that for thoracotomy. There is an uncertainty surrounding the evidence for its application in lobectomies, and further studies should determine if long term results are comparable with those achieved with thoracotomy.

Contributors: AS, TT, and JvdM were responsible for study concept and design. TT and AS were responsible for acquisition of the data and administrative, technical, or material support. AS and JL analysed the data and provided statistical expertise. AS drafted the manuscript. All authors interpreted the results and critically revised the manuscript for important intellectual content. TT and AS are guarantors.

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