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

Artyom Sedrakyan, Jan van der Meulen, James Lewsey, Tom Treasure

Health Services Research Unit, Department of Public Health and Policy, London School of Hygiene and Tropical Medicine, London WC1E 7HT

Artyom Sedrakyan *honorary lecturer and research scholar*

Jan van der Meulen *senior lecturer*

James Lewsey *lecturer*

Cardiothoracic Unit, Guy's Hospital, London SE1 9RT

Tom Treasure *professor of cardiothoracic surgery*

Correspondence to: T Treasure Tom.Treasure@ukgateway.net

BMJ 2004;329:1008–10

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.

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. Randomised trials were identified by searching Medline, Embase, and the Cochrane controlled trials register from 1980 to 2003 (see also bmj.com). We also searched the reference lists of randomised trials and reviews to look for additional studies. Twelve unique studies met all inclusion criteria, and 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. We evaluated methodological quality of included studies based on study description, randomisation procedure, concealment of allocation, and dropouts and intention to treat analysis.[2] Blinding was not applicable. We could not carry out meta-analysis because of the qualitative diversity of the outcomes and reported estimates.

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 (table 1). All studies reported a reduced need for pain medication and three studies[3–5] reported significantly shorter hospital stays in patients in the intervention group (table 2). Two studies 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),[5 6] and one 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.[7] Two studies that compared video assisted thoracic surgery with pleural drainage reported substantially fewer recurrences of

ELPS *This is the abridged version of an article that was posted on bmj.com on 22 September 2004: http://bmj.com/cgi/doi/10.1136/bmj.38243.440486.55*

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[5]	Randomised	Sealed envelope	Not clear	Yes	27	NR	NR
Sekine 1999[7]	Randomised	Not described	NR	Not clear	32	34	0
Waller 1994[6]	Randomised	Sealed envelope	Concealed	Yes	47	18	0
Gebhard 1996[3]	Randomly allocated	Not described	NR	Not clear	NR	NR	NR
Abdala 2001[4]	Randomly assigned	Not described	NR	Yes	NR	NR	NR
Tschopp 2002[8]	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.

pneumothorax in the intervention group (0 *v* 8[4] and 1 *v* 10[8]).

Minor resection—Three randomised studies that compared video assisted thoracic surgery with conventional thoracotomy enrolled 147 patients.[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. Sugi et al found no difference in survival after video assisted thoracic surgery versus conventional surgery 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[13] (table 2).

Discussion

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 sur-

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[5]	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[7]	20/18	NR	NR	NR	Diclofenac 8 *v* 16†	Atelectasis 2 *v* 5	NR
Waller 1994[6]	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[3]	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[4]	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[8]	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.

gery time, use of pain medication, and length of hospital stay. In two trials more recurrences of pneumothorax were observed with video assisted thoracic surgery than with thoracotomy.[6 7] These studies were performed relatively early in the development of the technique, and as surgeons become more experienced fewer recurrences are expected to occur. This outcome related to the "learning curve" should not serve as a justification for underuse of video assisted surgery in thoracic surgical units.

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 in our study, it is consistent with and substantiates the findings of relatively large cohort studies. 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] Although VATS lobectomy has gained in popularity recently, performing a major resection in what is essentially a closed chest and inability to routinely perform node dissection are still major concerns among surgeons.[13]

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 costs associated with video assisted minor resections than with conventional thoracotomy.[11] Some other investigators reported higher operative costs associated with such minor resections.[18] 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: See bmj.com
Funding: None.
Competing interests: None declared.
Ethical approval: Not required.

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

1 Wakabayashi A. Expanded applications of diagnostic and therapeutic thoracoscopy. *J Thorac Cardiovasc Surg* 1991;102:721-3.
2 Jadad AR, Moore RA, Carroll D, Jenkinson C, Reynolds DJ, Gavaghan DJ, et al. Assessing the quality of reports of randomized clinical trials: is blinding necessary? *Control Clin Trials* 1996;17:1-12.
3 Gebhard FT, Becker HP, Gerngross H, Bruckner UB. Reduced inflammatory response in minimal invasive surgery of pneumothorax. *Arch Surg* 1996;131:1079-82.
4 Abdala OA, Levy RR, Bibiloni RH, Viso HD, De Souza M, Satler VH. [Advantages of video assisted thoracic surgery in the treatment of spontaneous pneumothorax]. *Medicina (B Aires)* 2001;61:157-60.
5 Ayed AK, Al-Din HJ. Video-assisted thoracoscopy versus thoracotomy for primary spontaneous pneumothorax: a randomized controlled trial. *Med Principles Pract* 2000;9:113-8.
6 Waller DA, Forty J, Morritt GN. Video-assisted thoracoscopic surgery versus thoracotomy for spontaneous pneumothorax. *Ann Thorac Surg* 1994;58:372-7.
7 Sekine Y, Miyata Y, Yamada K, Yamada H, Yasukawa T, Saitoh Y, et al. Video-assisted thoracoscopic surgery does not deteriorate postoperative pulmonary gas exchange in spontaneous pneumothorax patients. *Eur J Cardiothorac Surg* 1999;16:48-53.
8 Tschopp JM, Boutin C, Astoul P, Janssen JP, Grandin S, Bolliger CT, et al. Talcage by medical thoracoscopy for primary spontaneous pneumothorax is more cost-effective than drainage: a randomised study. *Eur Respir J* 2002;20:1003-9.
9 Santambrogio L, Nosotti M, Bellaviti N, Mezzetti M. Videothoracoscopy versus thoracotomy for the diagnosis of the indeterminate solitary pulmonary nodule. *Ann Thorac Surg* 1995;59:868-71.
10 Ayed AK, Raghunathan R. Thoracoscopy versus open lung biopsy in the diagnosis of interstitial lung disease: a randomised controlled trial. *J R Coll Surg Edinb* 2000;45:159-63.
11 Miller JD, Urschel JD, Cox G, Olak J, Young JE, Kay JM, et al. A randomized, controlled trial comparing thoracoscopy and limited thoracotomy for lung biopsy in interstitial lung disease. *Ann Thorac Surg* 2000;70:1647-50.
12 Sugi K, Kaneda Y, Esato K. Video-assisted thoracoscopic lobectomy achieves a satisfactory long-term prognosis in patients with clinical stage IA lung cancer. *World J Surg* 2000;24:27-31.
13 Kirby TJ, Mack MJ, Landreneau RJ, Rice TW. Lobectomy—video-assisted thoracic surgery versus muscle-sparing thoracotomy. A randomized trial. *J Thorac Cardiovasc Surg* 1995;109:997-1002.
14 Craig SR, Leaver HA, Yap PL, Pugh GC, Walker WS. Acute phase responses following minimal access and conventional thoracic surgery. *Eur J Cardiothorac Surg* 2001;20:455-63.
15 Rivas De Andres JJ, Freixinet Gilart J, Rodriguez De Castro F. [Spanish multicenter study of video-assisted thoracoscopy surgery]. *Arch Bronconeumol* 2002;38:60-3.
16 Margolis M, Gharagozloo F, Tempesta B, Trachiotis GD, Katz NM, Alexander EP. Video-assisted thoracic surgical treatment of initial spontaneous pneumothorax in young patients. *Ann Thorac Surg* 2003;76:1661-4.
17 Hatz R, Kaps M, Meimarakis G, Loehe F, Muller C, Furst H. Long-term results after video-assisted thoracoscopic surgery for first-time and recurrent spontaneous pneumothorax. *Ann Thorac Surg* 2000;70:253-7.
18 Hazelrigg SR, Nunchuck SK, Landreneau RJ, Mack MJ, Naunheim KS, Seifert PE, et al. Cost analysis for thoracoscopy: thoracoscopic wedge resection. *Ann Thorac Surg* 1993;56:633-5.

(Accepted 13 August 2004)

doi 10.1136/bmj.38243.440486.55