Thorax Online First, published on January 31, 2006 as 10.1136/thx.2005.046847

Effect of training on patient outcomes following lobectomy

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Manuscript category: Original article
Running title: “Training in lobectomy and outcomes”
Word Count Abstract: 194 Text: 2154
Key Words: Training, Lobectomy, Mortality, Morbidity, Thoracic surgery.

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Presented at the 3rd EACTS-ESTS Joint Meeting, Leipzig, Germany, September 2004

Abstract

Background: Little is known about the effect training has on outcomes in thoracic surgery. We examined the impact of training on outcomes following lung resection, focusing on lobectomy as a marker operation.

Methods: We identified 328 consecutive patients who underwent lobectomy at our institution between 1st October 2001 and 30th June 2003. Data was collected prospectively during the patient's admission, as part of routine clinical practice and validated by a designated audit officer. Patient characteristics and post-operative outcomes were compared between trainee led and consultant led operations.

Results: 115 (35.1%) cases were performed by trainee thoracic surgeons as first operator. There were no significant differences between trainees and consultants regarding patient characteristics, including demographics, and pulmonary and non-pulmonary risk factors. In-hospital mortality was similar between trainee and Consultant cases, 3.5% and 2.8% ($p>0.99$), respectively. Outcomes between both groups were not significantly different, with respect to respiratory, cardiovascular, renal, neurological, chest infection, bleeding, and gastrointestinal complications. Survival rates at 1-year for trainee procedures was 82.6% compared to 81.7% for consultant procedures ($p=0.83$).

Conclusions: With appropriate supervision, trainee thoracic surgeons can perform lobectomies safely and without in any way compromising short or intermediate term patient outcome.

Introduction

All healthcare organisations have to balance between the need to provide a quality service, while at the same time allowing for sufficient time for surgical training [1]. With surgical performance under constant scrutiny, some consultant surgeons may be inclined to reduce the number of operations they allow a trainee to lead, which is at odds with the training requirements of junior surgeons. On top of which, the new European Working Times Directive is reducing junior doctors' hours, thus leading to even less exposure and training opportunities.

Several studies have been published examining the impact of training on outcomes in cardiac surgery [2-6]. In 2001 Jenkins and colleagues, in a study involving 6,037 cardiac surgery operations, published their experience of surgical training and concluded that with appropriate case selection, training in cardiac surgery can achieve good results [2]. Our own institution recently published a report with similar conclusions [6]. However, data comparing trainee surgeons with their more experienced colleagues in thoracic surgery is sparse and very little is known about the outcomes.

The Society of Cardiothoracic Surgeons of Great Britain and Ireland have used lobectomy as a marker operation to assess perioperative outcomes of individual Consultant surgeons. As it is the commonest major thoracic surgical procedure performed, it forms the basis for thoracic surgical training. We therefore, examined the impact of training on outcomes following lung resection, focusing on lobectomy as a marker operation.

Methods

Patient Population and Data

We performed a retrospective study on a total of 328 consecutive patients undergoing lobectomy between 1st October 2001 and 30th June 2003 at the Cardiothoracic Centre-Liverpool.

All data was collected prospectively by the surgical teams during the patient admission as part of routine clinical practice and validated by a designated Audit Officer. The validation consisted of examining all entries in our Thoracic Surgery Registry (Veritas Thoracic Version 2.0.04; Aurora Computer Services Ltd 1998) and checking for completeness and consistency against the patients' medical records. Any inconsistencies were flagged back to the appropriate surgical team for clarification and amendments where made when applicable. All entries were also cross-referenced against other sources in the hospital to ensure all cases had been captured.

Data collected included patient pre-operative characteristics, lobe removed, in-hospital outcomes , and post-operative staging for primary tumours. Whether the lobectomy was performed with the trainee as first operator was also documented.

Chronic obstructive pulmonary disease (COPD) was defined as patients with a diagnosed history of COPD requiring use of bronchodilators or steroids. Current smokers were defined as patients smoking within 2 months prior to surgery. In-hospital mortality was defined as death within the same hospital admission regardless of cause. Re-exploration for bleeding included any patient who required surgical reoperation after initial departure from the operating theatre. Respiratory complications included postoperative mechanical ventilation >24 hours or reintubation for ventilatory support after the day of surgery; pneumonia - defined as fever, leucocytosis pulmonary infiltrate requiring antibiotic therapy; air leak from thoracostomy tubes for more than six days postoperatively; lobar collapse on postoperative chest radiograph; empyema and bronchopleural fistula. Cardiovascular complications included new requirement for pharmacologic or other management of cardiac arrhythmias, need for postoperative inotropic support, pulmonary embolism and myocardial infarction. A postoperative rise in serum creatinine above 200µmol/litre or requirement of postoperative dialysis support in a patient with normal preoperative renal function was considered to be a renal complication. A postoperative new cerebrovascular accident or transient ischaemic attack was considered to be a neurological complication. Postoperative gastrointestinal complications were in line with The Society of Cardiothoracic Surgeons of Great Britain and Ireland definition and include gastrointestinal bleeding, pancreatitis, ischaemic bowel and perforation [7].

Patient Follow-up

Patient records were linked to the National Strategic Tracing Service (NSTS), which records all deaths in the United Kingdom. To establish current vital status at 1-year, patients were matched to the NSTS based on patient name, National Health Service number, date of birth, gender, and postcode.

Surgical Technique

The standard surgical approach was a posterolateral thoracotomy through the fourth or fifth intercostal space. The pulmonary vessels were doubly ligated and divided in between. The bronchus was stapled and divided distally. The individual suture material and mechanical stapling device differed between consultant surgeons, but the surgical technique and approach to a lobectomy was similar. Two intercostal drains were inserted in all cases at the end of the procedure . An epidural catheter was used to administer a mix of 0.1% Bupivacaine and 5 micrograms / ml Fentanyl for postoperative analgesia unless contraindicated.

During a junior surgeon's training at the centre, they are expected to perform thoracotomies, wedge lung resections and other minor thoracic surgical procedures at the commencement of training, while assisting in the performance of major lung resections. They then proceed to closely supervised segmentectomies, lobectomies and pneumonectomies. As the trainees progress to their final years of surgical training they become independent operators. The consultant surgeon is always immediately available for advice or help in case of difficulties.

Statistical Analysis

Continuous variables are shown as median values with 25th and 75th percentiles, due to non-normality of data. Categorical variables are shown as a percentage. Comparisons were made with Wilcoxon rank sum tests and Chi-square tests as appropriate. When appropriate, the Yates continuity correction was used. Deaths occurring as a function of time were described using the product limit methodology of

Kaplan and Meier [8]. In all cases a p value <0.05 was considered significant. All statistical analysis was performed with SAS for Windows Version 8.2.

Results

Of the 328 lobectomy operations undertaken during the study period, 115 (35.1%) were performed by a trainee thoracic surgeon as first operator. A trainee surgeon in years 1 to 3 of their training performed 73 cases and trainees in years 4 to 6 performed 42 cases.. The patient characteristics based on whether the lobectomy was performed by a trainee or not are shown in Table 1. No significant differences were found with respect to age, sex, respiratory function, smoking status, COPD, priority, and primary tumours.

Table 1: Patient characteristics

	Trainee led (n=115)	Consultant led (n=213)	P value
Age (years)	70.1 (60.9 - 75.9)	68.7 (61.7 - 73.8)	0.51
Female (%)	57.4 (66)	51.6 (110)	0.32
FEV1 %	76.1 (61.5 - 90.9)	75.4 (61.3 - 87.3)	0.38
FVC %	88.4 (78.1 - 101.6)	87.6 (73.6 - 98.5)	0.22
Current smokers (%)	31.3 (36)	33.8 (72)	0.64
COPD (%)	21.7 (25)	23.5 (50)	0.72
Non-elective surgery (%)	3.5 (4)	3.8 (8)	0.89
Primary tumour (%)	94.8 (109)	95.3 (203)	0.84

Number of patients in brackets. FEV1, Forced Expiratory Volume First Second; FVC, Forced Vital Capacity; COPD, Chronic Obstructive Pulmonary Disease. Continuous variables shown as median value with 25^{th} and 75^{th} percentiles. Categorical variables shown as a percentage.

The different lobes removed by either trainee or consultant thoracic surgeons are shown in Table 2. No significant difference was observed.

Table 2: Lobe removed

	Trainee led (n=115)	Consultant led (n=213)
Left upper (%)	25.2 (29)	29.6 (63)
Left lower (%)	13.0 (15)	12.7 (27)
Right upper (%)	40.9 (47)	37.6 (80)
Right middle (%)	4.3 (5)	7.0 (15)
Right lower (%)	16.6 (19)	13.1 (28)

P value = 0.69 (chi-square test). Categorical variables shown as a percentage. Number of patients in brackets.

Table 3 shows in-hospital outcomes for trainee and consultant lobectomy operations. In-hospital mortality for trainee and consultant procedures was similar (3.5% versus 2.8%; p>0.99). No differences existed with respect to respiratory, chest infection, cardiovascular, renal, neurological, bleeding and gastrointestinal complications. The average post-operative length of stay was also similar between both groups.

Table 3: Post-operative outcomes

	Trainee led (n=115)	Consultant led (n=213)	P value
In-hospital mortality (%)	3.5 (4)	2.8 (6)	0.74
Respiratory complication (%)	13.0 (15)	16.4 (35)	0.42
Infection complication (%)	3.5 (4)	4.2 (9)	0.74
Cardiovascular complication (%)	8.7 (10)	8.9 (19)	0.94
Renal complication (%)	3.5 (4)	4.2 (9)	0.74
Neurological complication (%)	1.7 (2)	1.9 (4)	0.93
Re-exploration for bleeding (%)	0 (0)	2.4 (5)	0.10
Gastrointestinal complication (%)	1.7 (2)	0.9 (2)	0.53
Length of stay (days)	8 (7 - 11)	8 (7 - 11)	0.58

Number of patients in brackets.
Continuous variables shown as median value with 25th and 75th percentiles.
Categorical variables shown as a percentage.

A significant difference did exist with respect to post-operative staging in primary tumours; with the consultant lobectomy operations being performed on higher staged patients (p=0.032; Table 4).

Table 4: Post-operative staging in primary tumour

	Trainee led (n=109)	Consultant led (n=203)
Stage		
Ia (%)	31.1 (34)	30.0 (61)
Ib (%)	51.4 (56)	36.0 (73)
IIa (%)	3.7 (4)	8.4 (17)
IIb (%)	10.1 (11)	12.8 (26)
IIIa (%)	3.7 (4)	12.8 (26)

P value = 0.032 (chi-square test for trend). Categorical variables shown as a percentage.

Fifty-nine (18%) deaths occurred during the one-year follow-up period. Follow-up was complete for all patients. No significant difference existed between the groups (p=0.83). Survival at 1-year for trainee procedures was 82.6% compared to 81.7% by consultants (Figure 1).

Discussion

Increasing public scrutiny of individual surgeons' results has led to greater caution among senior surgeons to provide training, due to the general belief among clinicians that trainee surgeons are associated with increased morbidity and a prolonged hospital stay, and therefore increased hospital costs. Reduction in junior doctors hours have also affected the time a surgeon in training spends in an operating theatre.

Surgical training in cardiac surgery is increasingly demonstrated as safe [2-6]. Data from our own institution has shown that after adjusting for case-mix, with careful case selection, training does not adversely affect the early and mid-term outcomes of CABG. In-hospital morbidity and mortality results were similar between consultant and trainee surgeons, but as importantly, the adjusted survival at 4-years was also not significantly different [6]. Training in off-pump CABG has also been shown to be safe with acceptable results [9,10].Data has not been published, however, comparing consultant and trainee surgeon results for thoracic surgery.

In our study, trainees performed a significant proportion of the caseload of lobectomies (35.1%). The preoperative patient characteristics did not show any significant difference between the trainee led and consultant led cases. However, as most of the cases were a result of primary lung tumours, an analysis of the tumour stages revealed a clear case selection for training. Higher TNM stages being used as a surrogate marker for the technical difficulty of a particular case indicate that the trainee was more likely to operate on a patient with UICC TNM Stage 1 or 2 tumours than a consultant surgeon.

It is also generally believed that a lower lobectomy is usually technically easier than an upper lobectomy. However, there was no significant difference between the proportions of particular lobe removed, between consultants and trainees. Despite this lack of objective data, individual patients may have been selected as unsuitable for training based on subtle clinical reasons. These reasons are difficult to define in prospective as well as retrospective studies. The competence level of individual trainees also impacts on the suitability of a particular case for training. What is more significant is that even if in a particular case the trainee is not the first operator, there are often parts of the case such as thoracotomy and closure of the thoracotomy wound which are often used for training purposes. Again retrospective evaluation limits our ability to obtain such data, although in our institution we record the trainee as the primary surgeon on an intention to treat basis. However, prospective collection of data in our database will ensure the actual level of trainee participation in each individual case.

In our study the postoperative mortality and morbidity was not significantly different between consultant and trainee led cases. The postoperative length of stay was also similar between the two groups. Thus there is no significant difference in early postoperative patient outcomes between trainees and consultants. Survival up to 1-year after surgery follows practically identical paths in both the groups (Figure 1). Early survival patterns are similar between consultant and trainee led groups and correlate well with national standards.

There are several limitations in our study. Firstly it is an observational study and could be biased by factors not recorded within our Thoracic Surgery Registry. Another limitation is the fact that the trainee results will probably reflect in part consultant's performance due to the assistance they would have given to the junior surgeon. Unfortunately, we cannot quantify the full extent of involvement by the consultants in this retrospective data. Also, as a result of the fairly recent reference time frame, long-term survival data is not available for the cohort of patients in our study. It is possible that long-term survival may differ between consultant and trainee cases as a result of case selection.

With increasing scrutiny of surgical performance and need for accountability not only in the United Kingdom but worldwide, it is important to audit surgical performance regularly and the same is true for trainee thoracic surgeons. However, adequate allowance must be made for differences in case-mix, if they exist. There is a current trend to focus on the importance of wet-labs and simulation in surgical training [11]. However, surgical skills require the integration of decision-making and mechanical processes [12]. Wet-labs are invaluable in imparting the basic surgical skills and maximising the trainee's time in the acquirement of new techniques and their perfection. Supervised training in the operating theatre however, is exceedingly important to develop the decision-making skills or strategy. Initially, the supervisor plays an active role in the operation having to even occasionally take over from the trainee especially if the patient's clinical condition or pathological anatomy deviates from the norm. As training progresses the trainee begins to anticipate such deviations and is able to develop their own strategy to manage such situations. Thus the role of the trainer then becomes more passive. It is obviously of paramount importance that at no time does the patient come to any harm by having the trainee operate on them, but that the trainee becomes better equipped to deal with real-life situations for the benefit of his or her future surgical practice. Studies such as ours are important as they highlight this often-ignored aspect of trainee surgical outcomes and should encourage supervised thoracic surgical training in the operating theatre.

In conclusion, with appropriate supervision, trainee thoracic surgeons can perform lobectomies safely and without in any way compromising results in the short or intermediate term. While a detailed prescription for training in thoracic surgery is beyond the scope of this article, the basic principles should include the acquisition and perfection of technical skills in a wet-lab or simulator with a simultaneous and gradual progression in supervised training within the operating theatre. There should be continuous feedback from the supervisor on the path to surgical competence for the trainee.
Future prospective studies are essential to validate our conclusions as well as collect objective data on the actual amount of supervision necessary in theatre for an individual trainee to attain technical and decision-making competencies. Such studies should also attempt to delineate the exact role of wet-labs and simulators in parallel to training within the operating theatre.

Acknowledgements
We would like to acknowledge the co-operation given to us by Mr. M. J. Drakeley, Consultant cardiothoracic surgeon.

Funding
No funding.

Ethical approval
Approval was obtained from the hospitals academic committee.

Conflict of interest
None declared.

Contributorship
Study concept and design (NC, ADG); study retrieval and data extraction (NC, ADG, RG); analysis and interpretation of data (NC, ADG, RG, ASS, RDP); drafting of manuscript (NC, ADG); critical revision of manuscript for important intellectual content (RG, NKM, MHC, ASS, RDP).

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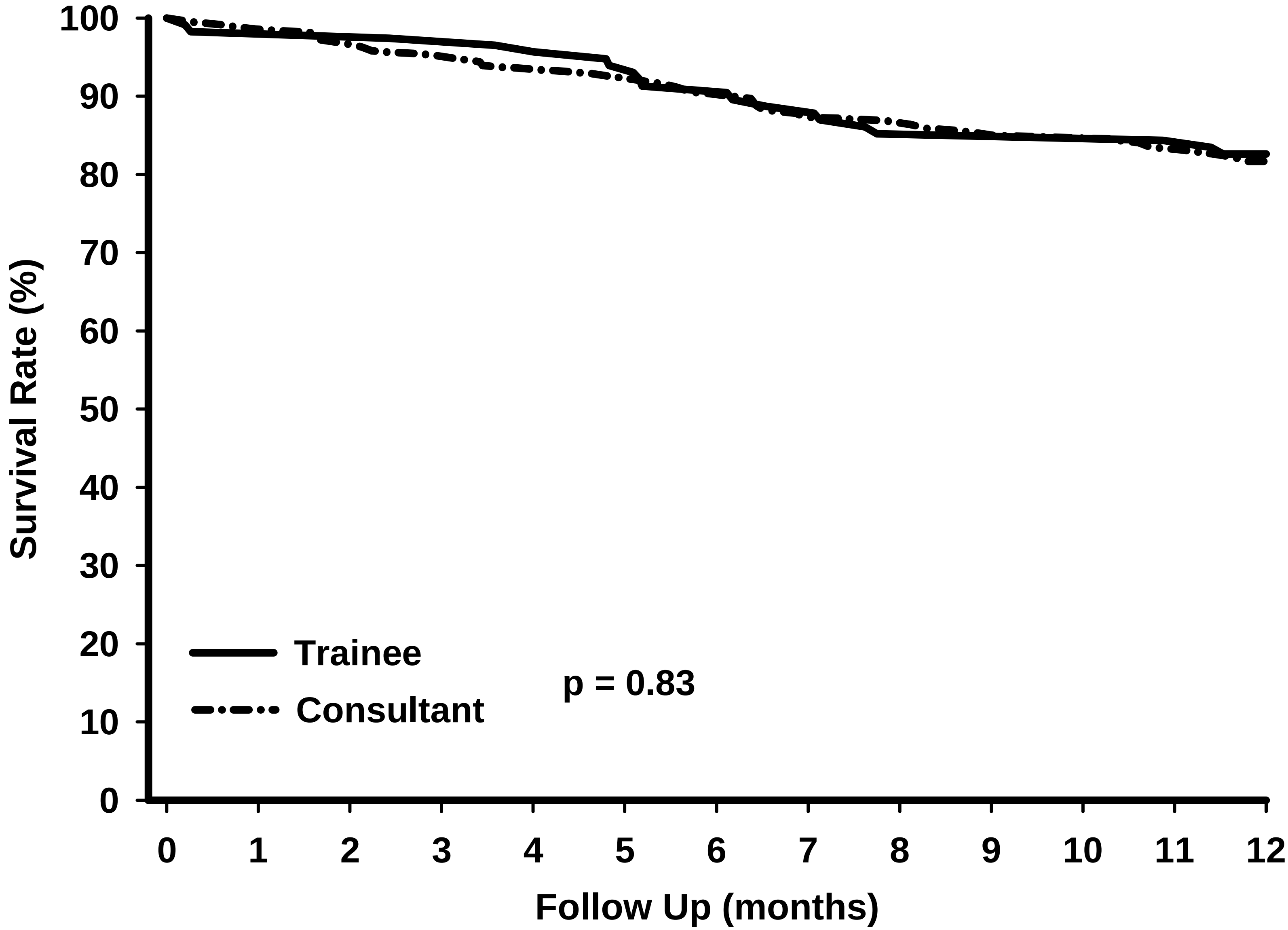
Figure Legends

Figure 1: Observed survival following lobectomy


100
90
80
70
60
50
40
30
20
10
0
Survival Rate (%)
Trainee
Consultant
p = 0.83
0 1 2 3 4 5 6 7 8 9 10 11 12
Follow Up (months)