The role of the emphysema multidisciplinary team in a successful lung volume reduction surgery programme†

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Abstract

OBJECTIVES: Lung volume reduction surgery (LVRS) for advanced emphysema is well established, with strong evidence from the National Emphysema Treatment Trial. However, there is still reluctance to offer the procedure, and many have looked for alternative, unproven treatments. The multidisciplinary approach has been well established in treatment of lung cancer and, more recently, in coronary artery surgery. We reviewed our practice to validate the role of our multidisciplinary team approach in our LVRS programme.

METHODS: Our multidisciplinary approach employs respiratory physicians, radiologists and surgeons involved in case selection, who meet on a regular basis. Cases are selected on the basis of clinical presentation, imaging (radionuclide lung perfusion and computerized tomography) and respiratory physiology. Retrospective analysis of prospectively collected data on 633 patients referred for lung volume reduction surgery between July 1995 and July 2013.

RESULTS: Six hundred and thirty-three patients (422 male) were referred for LVRS, of whom 253 (178 male; median age 61 years (range 37–79 years)] underwent 292 LVRS procedures. There were 268 video-assisted thoracoscopic surgical procedures, of which 13 were one-stage bilateral procedures and 37 required a staged second side. Overall median hospital stay was 13 (4–197) days, during which 11 patients died. Prolonged hospital stay was associated with increasing age and with duration of air leak, which in turn was associated with diffusion capacity and forced expiratory volume in 1 s.

CONCLUSIONS: The outcomes of a successful LVRS programme are not only dependent on good surgical technique and post-operative care. Case selection and work-up by a dedicated multidisciplinary approach for emphysema patients plays an invaluable and integral part in an LVRS programme.

Keywords: Advanced emphysema • Multidisciplinary team • Video-assisted thoracoscopic surgery • Lung volume reduction surgery

INTRODUCTION

In the Western world, chronic obstructive pulmonary disease (COPD) is probably the fourth most common cause of death in middle-aged to elderly men after ischaemic heart disease, lung cancer and cerebrovascular disease. It has been estimated that at least 14 million patients have COPD in the USA, and at least 2 million of those patients suffer predominantly from emphysema [1, 2].

Advanced emphysema leads to loss of elasticity with consequent air trapping and hyperexpansion. Lung volume reduction surgery (LVRS) is aimed at removing the non-functional emphysematous parts of the lung, thereby improving function. Although Brantigan and Mueller performed lung reduction by way of staged thoracotomies with resection and oversewing of the areas of most severe emphysema in the 1950s [3], it was Cooper and colleagues who popularized the procedure in the 1990s [4].

The ground-breaking results of the National Emphysema Treatment Trial (NETT) support LVRS as an important therapeutic intervention for highly selected patients who have emphysema [5]. The NETT multicentre trial not only validated the role of LVRS in advanced emphysema but also demonstrated that patients undergoing LVRS who had predominantly disease of the upper lobes and poor exercise capacity experienced significant improvements in quality of life and exercise capacity and lower mortality in comparison to medically treated patients. This trial also identified a high-risk subset of patients (forced expiratory volume in 1 s <20% of predicted and diffusion capacity <20% of predicted) who were felt to be at excessive risk of peri-operative mortality [5, 6]. Apart from the risk of mortality, the other significant risk in this particular cohort of patients is prolonged air leakage, due to the friable nature of the lungs. All of the recent reports of LVRS have been dominated by the complication of frequent and prolonged air

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leakage caused by the friable nature of the underlying lung parenchyma [7, 8].

Although there was an initial rise in LVRS numbers, the poor selection, increased air leakage and mortality led to only select centres offering this procedure. In spite of evidence for the value of LVRS, it is still an underprovided procedure in Europe and in the USA, with the number of procedures performed not being in proportion to the incidence on the basis of selection criteria [9]. This has also led to increased use of alternative forms of treatment in the hope of offering patients benefit with reduced risks. These endobronchial therapies have not yet matched the results of the NETT trial but have shown improved outcomes for certain para-endobronchial valve (EBV) therapies. The value of multidisciplinary teams has been evidenced in thoracic surgery in lung and oesophageal cancer practice as well as in coronary artery surgery [14, 15].

Here, we review our multidisciplinary team (MDT) performance, its role in our practice and its contribution to our results.

MATERIALS AND METHODS

Patient population

We have been performing LVRS since 1995 and established an LVRS MDT meeting in 1997. In 1998, an electronic database was created for all patients referred for possible LVRS.

Surgical strategy

Initially, LVRS was performed via median sternotomy. Subsequently, we have adopted a policy of video-assisted thoracoscopic surgery (VATS). The favoured approach is staged bilateral VATS, with the patients choosing the timing of the second operation [16]. However, a single-stage bilateral procedure is performed if a counselled patient prefers to have both sides treated at the same time to avoid repeated operations and general anaesthetics. Since 2013, we also consider patients for EBV insertion. The selection criteria for this procedure have remained the same as for video-assisted thoracoscopic (VAT) LVRS, but we reserve EBV insertion for patients who have a surgical contraindication for VATS, who have a higher anaesthetic risk for VAT LVRS or who choose EBV insertion after counselling on the risks and benefits of VAT LVRS and EBV insertion.

Specialist lung volume reduction surgery clinic

We have a dedicated outpatient clinic for emphysema surgery, which is jointly offered by the respiratory medicine and thoracic surgery departments. Patients from our own hospital as well as patients who have been worked up by physicians in referring district general hospitals are seen and assessed in this clinic by both the physicians and the thoracic surgeons. The patients undergo respiratory function tests, including the measurement of arterial blood gases, diffusion capacity and lung volumes by body plethysmography. We believe that body plethysmography offers a better assessment of lung volumes such as residual volume and total lung volume. The patients undergo a quantitative radionuclide perfusion scan in our centre locally to avoid inter-technique variability and to determine the targets for the volume reduction by identifying the non-perfused areas.

Multidisciplinary team

Our MDT meets once every 2–3 months, when ~25 patients are discussed. Respiratory physicians, thoracic surgeons, a radiologist and the multidisciplinary meeting co-ordinator attend the meeting. The two surgeons (David A. Waller and Sridhar Rathinam) perform all the LVRS procedures in the unit, and the respiratory physicians (Mike D. Morgan and Mick Steiner) have a clinical and research interest in COPD, emphysema and its impact on lifestyle, physiology and metabolism. Our unit also has a professor of physiotherapy with a special interest in pulmonary rehabilitation who was a member of the MDT until recently. All patients referred to either thoracic surgeons or respiratory physicians are discussed at the LVRS multidisciplinary meeting.

Selection criteria

All our patients undergo physiological studies as well as imaging to quantify the severity of disease and assess their suitability for LVRS. In order to be selected for LVRS, patients have to have significant symptomatic dysfunction judged by the modified Medical Research Council (mMRC) dyspnoea scale as grade 3–4. Spirometric inclusion criteria consist of a forced expired volume in 1 s of 20–40% of predicted, residual volume >200% of predicted, total lung capacity >120% of predicted and a residual volume-to-total lung capacity ratio >60%.

Anatomical criteria include the presence of heterogeneous emphysema with target areas of severe emphysema, as well as exclusion of any coexisting tumours on computerized tomographic scan. Physiological heterogeneity is assessed by radionuclide scintigraphy. This is quantified by calculating the so-called ‘Q score’, as determined by the ratio of perfusion in the target zone to the total lung perfusion. Patients with a Q score <10% are offered surgery. Patients with target areas in either upper or lower lobes are included; however, the lower lobe patients are appropriately counselled about the reduced benefits according to NETT results.

It is mandatory that the patients cease smoking and complete pre-operative pulmonary rehabilitation [13]. Exercise tolerance is assessed using the shuttle walk test, which is a standardized and externally paced field walking test conducted on a 10 m course. Before surgery but after rehabilitation, patients complete the Short Form 36 (SF-36) and EuroQol questionnaires. The SF-36 is a generic health status questionnaire, in which 36 questions cover the following eight health domains: physical functioning; social functioning; role limitations due to physical problems; role limitations due to emotional problems; mental health; energy/vitality; pain; and general health status. For each domain, scores are transformed to range from 0 (worst possible health status) to 100 (best possible health status). The EuroQol is also a generic questionnaire consisting of the following five dimensions: mobility; self-care; usual activities; pain and discomfort; and anxiety and depression. The scoring of these dimensions can be transformed into a single
We have a standardized patient pathway to assist referring primary care physicians and hospital physicians (Fig. 1).

**Data collection and database**

Our unit has a dedicated prospective LVRS database. We collect clinical data, co-morbidities, respiratory physiological parameters and perfusion quantification prior to surgery and at periodic time points following surgery to provide longitudinal outcome. The patients’ quality-of-life parameters are collected using EuroQol and SF-36 questionnaires both pre- and post-surgery to assess and monitor the impact on their lifestyle.

**Follow-up**

The patients who undergo surgery and who are monitored are followed up in our dedicated LVRS clinic. The patients are seen at 4 weeks, 3 and 6 months and annually. They regularly undergo pulmonary function tests to monitor their lung function, as well as quality-of-life assessments. If they are symptomatic, with deteriorating respiratory function, another perfusion scan is performed to assess the non-operated lung. The patient is discussed at the MDT and offered surgery on the second side. Our LVRS clinic and periodic surveillance practice is important in that this avoids patients being re-referred when pulmonary function tests have deteriorated to the extent that LVRS is no longer a possible option.

**RESULTS**

In total, 633 new patients (422 men and 211 women), median age 61 years (range 23–79 years), have been referred for possible LVRS. Some patients are discussed more than once, and all patients who may be going for a second procedure are also discussed again. Patients who have suitable targets but who are good physiologically and performance-wise are deferred. To date, 382 patients have not proceeded to LVRS. Fourteen patients are on the waiting list for LVRS or are still being assessed with further investigations. Forty-one patients were surgical candidates for a bullectomy rather than LVRS. The difference in demographics of the overall cohort and those who were offered LVRS are summarized in Table 1.

The majority of patients were considered unsuitable because of the absence of target areas for resection on a quantitative perfusion scan. A quarter of patients were considered too good, either by the medical team because their pulmonary function did not show severe enough airway obstruction and/or hyperinflation, or because the patients felt they were too good to consider surgery at this stage. The patients in the category of respiratory failure were those with hypercapnia and/or pulmonary hypertension. Some patients were turned down because of previous thoracic surgery or other associated respiratory conditions, such as frequent exacerbations, bronchiectasis or lung fibrosis (Fig. 2).

Sixteen patients who were initially felt not to be suitable were subsequently discussed and offered surgery. The median time between initial MDT discussion and surgery (after subsequent MDT decision) was 19 months (range 11 months to 6 years). The reasons were diffuse disease without targets (which changed subsequently), the patient’s functional status and the patient’s choice.

Thirty-two per cent of patients came from within Leicestershire. The percentage who proceeded to LVRS was similar whether they were from inside Leicestershire (39%) or not (41%; Figs 3A and 4).

Education of referring physicians on selection and outcomes and the formalization of a referral pathway have led to a higher rate of selection for patients in the MDT who have subsequently undergone surgery in recent years (Fig. 3B). Improved surgical and anaesthetic techniques have also contributed to an increase in the number of higher risk patients offered surgery over the years.

<table>
<thead>
<tr>
<th>Number</th>
<th>Total patients</th>
<th>LVRS cohort</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>634</td>
<td>253</td>
</tr>
<tr>
<td>Median age (years)</td>
<td>61</td>
<td>60</td>
</tr>
<tr>
<td>Age range (years)</td>
<td>23–79</td>
<td>37–79</td>
</tr>
<tr>
<td>Number of men</td>
<td>422 (66.5%)</td>
<td>178 (70%)</td>
</tr>
</tbody>
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LVRS: lung volume reduction surgery.
A total of 292 procedures were performed on 253 patients [median age 60 years (range 37–79 years), 178 men and 115 women]. Twenty median sternotomies and 268 VATS procedures were performed. In three of the VATS cases, we proceeded to conversion to an open thoracotomy because we were unable to perform the procedure by VATS. In 16 of the VATS procedures, LVRS was performed bilaterally in one stage, while 37 patients had a staged bilateral VATS procedure. The median time interval between first and second VATS was 3 years (range 2 months to 9.5 years).

Eight patients were considered for EBVs, of whom four had positive collateral ventilation and were not offered EBVs. Of the four patients who had an EBV inserted, two patients had this as a second stage procedure; in one patient on the same side as the previous VAT LVRS and in one patient on the contralateral side to the VAT LVRS.

The median stay in hospital for the 265 VATS patients was 13 days (range 4–197 days), during which 14 patients (5%) died. The 30 day mortality after VAT LVRS in our practice was 3% (nine patients). The long-term outcomes and improvement in patients’ quality of life have been published previously [13, 17].

DISCUSSION

Surgery for emphysema has advanced with time from the original description by Brantigan and Mueller [3]. The advent of stapling devices heralded a new age of LVRS, which was popularized by Cooper et al. [4]. Several groups adopted this procedure, with variable outcomes with regard to mortality and morbidity [17–19]. This necessitated the NETT to define the value of this procedure [5]. Although the initial results of the NETT showed a high mortality with LVRS, careful analysis highlighted that LVRS is an important therapeutic intervention for carefully selected patients who have emphysema [5]. It also demonstrated valid pointers in case selection that lead to better or adverse outcomes. Patients obtain maximal therapeutic and functional benefit when undergoing LVRS for upper lobe-predominant disease with poor exercise capacity. The NETT also identified a high-risk subset of patients (forced expiratory volume in 1 s < 20% and diffusion capacity < 20%) who were felt to be at excessive risk of peri-operative mortality [5, 6].

Prolonged air leakage has been a high risk associated with LVRS. Various adjuncts have been evaluated for reducing air leakage, with mixed success [7, 8, 20, 21]. It is the risk of mortality based on the original NETT report and concern about the prolonged air leakage that have been the main limiting factors in the adoption of this potentially valuable procedure. Lung volume reduction surgery is still a greatly underutilized procedure, given the incidence of COPD and advanced emphysema [9].

The advent of endobronchial valves and other technologies has been heralded as an alternative to LVRS, but the initial results did
not demonstrate the same improvement in lung volumes and performance status as LVRS. However, patients treated with EBVs showed an improvement in the St George’s Respiratory Questionnaire (SGRQ) [10, 11]. Identification of collateral ventilation and use of EBVs in patients who do not have collateral ventilation has been shown to result in better outcomes [22]. However, the fundamental difference between the two techniques, apart from surgery and air leakage, is that with LVRS the non-perfused, hyperinflated lung is stapled and excised, whereas with an EBV the whole lobe, including its perfused segments, is excluded [23].

We have treated more patients than our sister units in the UK, and results have been good for both symptom improvement and quality of life [16]. This is multifactorial, due to adoption of the VATS approach, using adjuncts to reduce air leakage and better anaesthetic techniques; however, we feel that our invaluable emphysema MDT plays a significant role in these results. The team, comprised of clinicians with an interest in various aspects of emphysema, mutually benefits the team and the patients, leading to better care. The standardization of investigations means that decision making is uniform, based on set selection criteria. This is reflected in the fact that there was no variation in proceeding to LVRS dependent on whether the patient was from the base hospital or a peripheral hospital, because all patients were assessed and worked up by our team.

The case selection and choice of therapy is made by a collective consensus. The feedback from the MDT to the referring respiratory physicians from district general hospitals has led to education of the physicians both on the value of LVRS and on the selection criteria, which has improved the proportion of patients offered LVRS by the MDT. The team also periodically analyses outcomes and ways of improving the options for those patients with poor lung function and quality of life.


The oncological MDTs have improved the cancer services in various oncological specialties and have had a significant positive impact on patient care, with a decrease in the referral-to-surgery times and improvement in resection rates [15]. Apart from achieving these favourable outcomes, it also avoids monodisciplinary decision making, which may deny patients the right counselling and treatment.

In our sister specialty of cardiac surgery, when percutaneous interventions were offered to patients who would have long-lasting benefits with coronary artery bypass grafting, a similar trend has started where all coronary angiograms are discussed in the Heart Team MDTs to decide on percutaneous coronary intervention or coronary artery bypass grafting on the merit of the investigation and projected patient benefit [14].

The MDT is an integral part of our constantly evolving specialty, so that patient care is always offered with multispecialty input on the basis of evidence, as well as maintaining continuity of care between the different specialties involved in the management of the patient. It offers a valuable focus for education and mutual learning to the various clinicians.

We believe that our good outcomes and patient satisfaction result from the integral role that our MDT provides in work-up and case selection. Currently, respiratory physicians and some surgeons offer patients endobronchial treatment without a multidisciplinary discussion. It is important that surgery for emphysema, and particularly newer forms of treatments such as endobronchial valves, coils and vapour therapy, should be offered only after discussion in a MDT with a surgeon present and after informed discussion with the patient. The National Institute of Clinical Excellence (NICE) recent guideline for endobronchial valves for emphysema has stated that this should be a standard [National Institute of Clinical Excellence. Bronchoscopic lung volume reduction with airway valves for advanced emphysema. London: Department of Health; 2013. http://guidance.nice.org.uk/IPG318/DraftGuidance. 1 September 2013].

Conclusions

The outcomes of a successful LVRS programme are not only dependent on good surgical technique and post-operative care. Case selection and work-up by a dedicated MDT for emphysema patients is an invaluable and integral part of an LVRS programme. In the current setting, where various options are available for management of advanced emphysema, an Emphysema MDT plays an integral part in the patient’s care.

Conflict of interest: none declared.

REFERENCES


[13] Oey IF, Morgan MD, Spyt TJ, Waller DA. Staged bilateral lung volume re-


APPENDIX. CONFERENCE DISCUSSION

Dr P. Van Schil (Antwerp, Belgium): The authors evaluated the role of a multidisciplinary team (MDT) approach in patients referred for lung volume reduction surgery. Over the years, they accumulated a large experience with surgery for emphysema and they demonstrate that good results can be obtained by implementation of an MDT approach, as is also valid for oncology, coronary artery disease and transplantation. They started a lung volume reduction surgical pro-

I have two questions. First, the MDT consists of a respiratory physician, a thoracic surgeon and a radiologist. Is there no specific role for a physiotherapist?

Dr Oey: Yes. We have Professor Singh, who is actually an expert in pulmonary rehabilitation. She is also the one who developed the shuttle walk test, which you may well be aware of, as an alternative to the 6 min walk test.

Dr Van Schil: Would a dedicated nurse not be useful also for follow-up of these patients?

Dr Oey: We have two thoracic nurse specialists, but they are not just for lung volume reduction and they don't need to come to our MDT meetings, but they are available for clinics.

Dr Van Schil: In the manuscript you mention that after introduction of this MDT, several changes were made in the diagnostic or therapeutic algorithm. What exactly changed, as this is a key issue in the evaluation of these patients, and how did this influence your results?

Dr Oey: Well, one thing, the operative technique had changed from median sternotomies to VATS. Because we had this electronic database, we realized that the morbidity of one-stage bilateral procedures was much higher than the uni-
lateral procedures. We also started to rely on the quantitative perfusion scan rather than the CT scan.

Dr Van Schil: Do you think you had poorer results before the introduction of the MDT?

Dr Oey: Well, we can't really compare because there were not many patients who actually underwent surgery without an MDT. The first procedure was done in December of 1995, and in early 1997 we already had an MDT.

Dr D. West (Bristol, United Kingdom): We have had our MDT for a much shorter time than you have. I'm just interested in your flow chart there. Not everyone goes for a Chatsis assessment. Do you think there are some people who don't have cross-ventilation but who still should have an operation?

Dr Oey: Well, I can only talk from what has been published. We don't have much experience in Chatsis and EBV. We only started it this year, and because it is available, we have used Chatsis. I know the radiologists don't like us to rely on a CT scan for whether you have got complete fissures or not. Having said this, we have done four EBVs with not that good a result, which is suggesting that, despite even Chatsis, they might have had collateral ventilation.

Dr W. Weder (Zurich, Switzerland): You showed us that some years ago, the acceptance rate between those who were referred and then finally got treatment was much lower, and in the last couple years, almost 90%, I would say, of the patients who got referred got the treatment, and you gave us the explanation that you are instructing the referring physicians. I think that is an important but also critical issue. How do you instruct the referring physicians? What are you asking for? Which patients should they refer for review to your specia-

ized group?

Dr Oey: I think the most important thing is actually to make them aware of the procedure itself. One of our team has actually gone out to peripheral hospi-
tals to talk to them. Therefore, they refer more patients to us, but I think also we tend to our MDT meetings, but they are available for clinics.