Published in final edited form as:

Thorac Surg Clin. 2015 ; 25(1): 47–54. doi:10.1016/j.thorsurg.2014.09.007.

Single Versus Bilateral Lung Transplantation: Do Guidelines Exist?

Varun Puri, MD, MSCI, G Alexander Patterson, MD, and Bryan F Meyers, MD, MPH

Department of Surgery, Division of Cardiothoracic Surgery; Washington University School of Medicine, St. Louis, MO, USA

Synopsis

An ongoing debate exists between proponents of single or double lung transplant for end-stage pulmonary disease. Short- and long-term outcomes, as well as individual and societal benefits are some of the key considerations. We examine the evidence that directly compares these two approaches and informs the debate about the relative merits of single and bilateral transplant.

Keywords

single lung transplantation; double lung transplantation; quality of life; pulmonary fibrosis; emphysema

Introduction

Lung transplantation (LTx) has been accepted therapy for end-stage pulmonary disease for over two decades now. Lung transplant operations, unlike other solid organ transplants, are somewhat unique in the fact that the donor block may be utilized for one recipient for a bilateral transplant or split to potentially benefit two patients with a single lung transplant each. The technical aspects of both operations have been well described and do not pose significant challenges. (1, 2) Vocal proponents of both approaches cite benefits for each, yet there remains a lack of high-quality evidence comparing the two approaches. In the absence of quality data to guide decisions, practice patterns remain largely institution or individual-specific and disparate. In this article, we examine the relative benefits and drawbacks of single versus bilateral lung transplantation for specific lung diseases supplemented by a summary of the available evidence. (Tables 1 and 2)

Bilateral transplant is the only acceptable transplant modality in patients with septic lung disease like cystic fibrosis or bronchiectasis for obvious concerns about contaminating the new lung with preexisting infection. Thus, for the purpose of our discussion, we will exclude

© 2014 Elsevier Inc. All rights reserved.

Corresponding Author: Varun Puri, MD, MSCI, Washington University School of Medicine, Division of Cardiothoracic Surgery, Campus Box 8234, 660 S. Euclid Ave., St. Louis, MO 63110, puriv@wudosis.wustl.edu, 314-362-6044 phone, 314-362-0626 fax.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

septic lung disease and accept, for that population, the superiority of a bilateral operation. Additionally, older patients with secondary pulmonary hypertension have anecdotally been considered preferentially for a bilateral transplant, however, Brown and colleagues have recently shown excellent short-term and intermediate outcomes in patients 65 years or older receiving a unilateral transplant. (3) Otherwise, both single and bilateral transplant have been performed for other common indications including chronic obstructive pulmonary disease (COPD)(4), interstitial lung disease (ILD)(5), and primary pulmonary hypertension(6). Single center and registry based studies have published comparative perioperative, intermediate, and long-term outcomes after single and bilateral lung transplant (1, 4–18) however no randomized trials or prospective, controlled studies have evaluated these two operations. Additionally, the relative individual, societal, and economic implications of these approaches have been widely debated. (12, 15)

Early Outcomes

Advocates of single lung transplantation cite the relatively simpler technical nature, the avoidance of a sternotomy, and the shorter duration of the procedure(14) as major advantages leading to improved immediate and perioperative outcomes. A registry database study of patients with interstitial lung disease by Meyer noted that early (1-month) survival in recipients aged 30 to 49 years was significantly better with single lung transplant (SLT) than bilateral lung transplant (BLT) (early, 90.9% versus 77.1%). Survival was also significantly better with SLT than BLT at this early time point time in those patients aged 50 to 59 years (early, 89.5% versus 81.7%).(5) Conversely, a smaller institutional study by Minambres showed the 30-day survival was 81% in patients who underwent SLT, and 92% in patients who underwent BLT.(14) Multivariable regression modeling to adjust for covariates and selection bias found that type of operation was not independently associated with short-term survival. Early experience at our center also showed no difference in 30-day mortality between recipients of SLT or BLT in a population of patients with pulmonary fibrosis.(7) A registry database study by Meyer and colleagues, evaluating patients with COPD, also found no difference in 30-day mortality between SLT and BLT in patients up to 60 years of age.(4) They did note a higher 30-day survival for SLT versus BLT (93% vs. 78%), however the patient population is from the 1991–97 time period, where arguably the BLT operation was still being learned and perfected. At the other end of the spectrum, Chang and colleagues evaluated a single institution database and noted a better 3-month survival with BLT compared to SLT and confirmed their findings in a multivariate analysis. (9)

Other authors have also compared commonly accepted measures of early postoperative outcomes and found no major difference between SLT and BLT. Minambres and colleagues noted identical duration of postoperative ventilation (SLT 32 hours, BLT 29 hours) and ICU stay (SLT 7 days, BLT 6 days) after these two operations at their institution. In another single center study reporting on patients with pulmonary hypertension, the median duration of intubation (7.5 vs 10 days), length of stay in the intensive care unit (10 vs 16 days), and hospital stay (32 vs 52 days) were not significantly different for the SLT and BLT, respectively.(11) While the differences in that study were not statistically significant, the

small sample size could not exclude the possibility that clinically important differences existed despite the absence of a statistically significant difference.

Functional Status and Quality of Life (QOL)

Spirometry, as measured by forced expiratory volume in 1 second (FEV1) or FEV1 % predicted, is a key objective indicator of functional status in both pre- and post-transplant patients. Spirometry is strongly correlated with quality of life in the lung transplant population.(12) Mason and colleagues studied the relative impact of SLT and BLT on FEV1 at their institution.(13) In 379 adult recipients, 6372 evaluations of postoperative FEV1 and forced vital capacity (FVC) were analyzed using longitudinal temporal decomposition methods for repeated continuous measurements. FEV1 % predicted was somewhat better after BLT as compared to SLT (65%, 58%, and 59% vs 51%, 43%, and 40% at 1, 3, and 5 years, p 0.03). FVC measurements also followed a similar pattern. In BLT patients, the post-transplant gains were more stable with fewer declines in FEV1 compared to SLT patients, yet FEV1 measurements in BLT patients did not reach double the values of SLT recipients.. The differences in FEV1 values between SLT and BLT were most pronounced in patients with COPD as the indication for transplantation. The authors concluded that “the advantage of spirometry values alone may not justify double lung transplantation”.(13)

Despite a growing interest in medical economics and patient-reported outcomes, health-related quality of life has been infrequently assessed after lung transplantation. Anyanwu utilized the EuroQol, a generic questionnaire developed to provide a simple method for assigning utility values to health, for evaluating QOL after SLT, BLT, and heart-lung transplantation. (19) Eighty seven patients awaiting LTx and 255 transplant recipients were enrolled. In the waiting list group, 61% reported extreme problems in at least one of the five EuroQol quality of life domains compared with 20% SLT recipients and 4% BLT recipients at 3 or more years after transplantation. The mean utility value (values range from zero for death and one for perfect health) for waiting list patients was 0.31, while it was 0.61 for SLT and 0.82 for BLT at 3 years after LTx. Problems in all five domains of EuroQol were more frequent in single lung recipients. Assessment with a visual analogue scale showed a similar trend. This study suggested that BLT leads to greater improvement in QOL compared to SLT, and the benefits are durable.

In 2005, Gerbase and colleagues compared a variety of measures including the 6 minute walk test, and quality of life using the St. George respiratory questionnaire (SGRQ) and a visual analog scale (VAS) in 44 patients who had undergone SLT ($n=14$) or BLT ($n=20$). (12) The SGRQ primarily studies three domains; respiratory symptoms, ability to perform routine activities, and impact of disease on daily life. Patients were followed for more than 2 years. Both single and bilateral transplant led to significant improvement in FEV1% predicted and QOL compared to baseline pre-transplant status. However, significantly lower spirometry values were observed in SLT patients compared to BLT patients over the long-term followup with the difference being 20% lower at each time point over 4 years. In contrast to the spirometric data, the performance on the 6 minute walk test and scores on the SGRQ were not significantly different between recipients of single versus bilateral transplant. Despite poorer objective parameters of recovery of lung function, SLT recipients

had long-term exercise tolerance and quality-of-life which was comparable to that seen in patients who received BLT.

Long-term Survival

Meyer and colleagues were among the first to study SLT vs. BLT using data from the United Network of Organ Sharing (UNOS) registry.⁽⁴⁾ They evaluated 2,260 lung transplant recipients (1835 SLT, 425 BLT) with COPD who underwent surgery between 1991 and 1997. Survival rates (%) at 30 days, 1 year, and 5 years for the patients aged < 50 years were 93.6, 80.2, and 43.6, respectively, for the SLT patients, and 94.9, 84.7, and 68.2, respectively, for the BLT patients. For patients aged 50 to 60 years, survival rates (%) were 93.5, 79.4, and 39.8 for the SLT patients compared with 93.0, 79.7, and 60.5 for the BLT patients. For those aged > 60 years, 1-year SLT survival (%) was 72.9 compared with 66.0 for the BLT group. Multivariate modeling, used to adjust for selection bias that might steer younger and fitter recipients to a bilateral procedure, confirmed a higher hazard for post-transplant mortality in patients aged 40 to 57 years who received SLT as compared to BLT. The authors concluded that SLT may offer acceptable early survival for recipients with end-stage COPD; however, long-term survival data favors the bilateral strategy in recipients until approximately age 60 years of age.⁽⁴⁾

In a related study in 2005, Meyer and his team analyzed post-transplant outcomes in patients with pulmonary fibrosis, again utilizing the UNOS database. ⁽⁵⁾ The study included data from eight hundred twenty-one patients (636 SLT, 185 BLT), aged 30 to 69 years, who were operated on between 1994 and 2000. In crude univariate analysis, early (1-month) and late (3-year) survival after SLT in recipients aged 30 to 49 years was better than with BLT (early, 90.9% versus 77.1%; late, 63.8% versus 46.2%, respectively). Unmatched early survival was also better with SLT than BLT at these time points in those patients aged 50 to 59 years. However, multivariate analysis and propensity score matching failed to show a statistical difference between survival after SLT and BLT, though a trend favoring SLT was observed. The authors concluded that their study results could not support the apparent preferential use of BLT for younger patients with pulmonary fibrosis.

A subsequent analysis of UNOS registry patients was conducted by Nwakanma in 2006.⁽¹⁶⁾ The authors of that study analyzed 1,656 initial LTx recipients, 60 years of age or older, who underwent operations from 1998 to 2004. For the 364 (28%) BLT and 1,292 (78%) SLT recipients, long-term survival was not statistically different between the two groups in multivariate analysis or propensity score matched analysis. Idiopathic pulmonary fibrosis and a donor tobacco history of more than 20 pack-years were significantly associated with increased mortality.

In 2008, Thabut et al reported on 9,883 patients who underwent LTx for COPD between 1987 and 2007 and were enrolled in the registry of the International Society for Heart and Lung Transplantation. ⁽¹⁷⁾ They noted that median survival for the entire cohort receiving lung transplantation for COPD was 5.0 years. The proportion of patients who underwent BLT increased over the study period from 21% to 56%. Median survival after bilateral transplant was longer than that after single lung transplant (6.41 years versus 4.59 years).

After adjusting for baseline differences between the two populations BLT was still associated with longer survival compared to SLT [hazard ratio for death was 0.83 (0.78–0.92)]. However, BLT did not confer a survival advantage over SLT for patients who were 60 years and older [hazard ratio 0.95 (0.81–1.13)].

From a more recent timeframe, Force et al conducted a health services research study utilizing the prospectively maintained database of the UNOS from 1987 to 2008, evaluating 3,860 patients with idiopathic pulmonary fibrosis. (10) Unadjusted analysis, comparing survival based solely on BLT versus SLT, showed a significant survival advantage for the BLT group with a mean survival of 7.4 years for the SLT group and 8.3 years for the BLT group. However, multivariate and propensity score matched analyses failed to show any survival advantage for BLT. One-year conditional survival, evaluating the overall survival of those who lived for at least 1 year after LTx, favored BLT (hazard ratio 0.73, 95% confidence interval 0.60 to 0.87). The authors noted that significant risk factors for early death were recipient age over 57 and donor age over 36 years. They concluded that “BLT should be considered for younger patients with idiopathic pulmonary fibrosis and results may be optimized when younger donors are used.”

Perhaps the most comprehensive view of long-term survival is provided by the annual report from the registry of the International Society for Heart and Lung Transplantation. The society published its 2013 report summarizing data from 1994–2011.(19) Adults who underwent lung transplant had a median survival of 5.6 years with unadjusted survival rates of 88% at 3months, 79% at 1 year, 64% at 3 years, 53% at 5 years, and 31% at 10 years. Patients undergoing bilateral transplant had a higher overall median survival compared to those undergoing SLT (6.9 years vs. 4.6 years). Additionally, recipients of BLT who survived to 1 year after transplant had a conditional median survival of 9.6 years, compared to 6.5 years for recipients of SLT. The registry database also noted an improved survival for transplants performed in the most recent era. Our institutional data also support a 5-year survival rate advantage in favor of BLT vs. SLT when LTx is performed for emphysema (66.7% vs. 44.9%). (20)

Outcomes in the High-Risk Recipient

Weiss et al evaluated the UNOS database for 1,256 patients with pulmonary fibrosis who underwent LTx between 2005 and 2007.(18) They divided the population into quartiles based upon the lung allocation score (LAS). Patients in the highest LAS quartile were more likely to receive BLT as compared to SLT (59.5% vs. 38.4%). In patients with the highest LAS, BLT was associated with a 14.4% lower risk of mortality at 1 year. This survival benefit was confirmed on multivariable analysis [hazard ratio 2.09 (95% confidence interval 1.07 to 4.10)] as well as in sensitivity analyses incorporating pulmonary hypertension. There were no differences in the 30- or 90- day mortality between SLT and BLT in any quartile on unadjusted or multivariable adjusted analysis.

With UNOS data suggesting an improved overall survival in bilateral recipients compared to SLT, the interaction between the lung allocation score and type of transplant was further studied by Black. (7) The authors evaluated 8,778 patients from the UNOS Thoracic

Transplant Database and used propensity matching to minimize other differences between the high and low LAS groups and between single and double lung transplants in the high LAS group. They reported on 8,050 patients with LAS less than 75 and 728 with LAS greater than or equal to 75. Significantly shorter survival was seen in those with high LAS who received a SLT when compared with those with high LAS who received a BLT (1-year survival 49% vs. 57%). This survival difference was a much greater than that seen in the same comparison among the low LAS patient population. The authors commented that “In the future, it will be important to determine whether there is an LAS cutoff point above which a single lung transplant should not be considered.”

Chronic Rejection

Neurohr et al analyzed their institutional LTx database and compared 46 SLT recipients to 30 BLT recipients. (15) All patients underwent LTx for pulmonary fibrosis. On univariate and multivariate analysis, SLT was a predictor for development of bronchiolitis obliterans syndrome stage 1. Subgroup analysis revealed no statistically significant difference for BOS-free survival between BLT recipients with or without pulmonary hypertension. Though episodes of acute rejection were a risk factor for development of BOS, there was no difference in the incidence of acute rejection episodes between SLT and BLT patients. Similarly, in another institutional study with small sample size (n=44), Gerbase noted that SLT was associated with a greater risk of BOS at 24 months (relative risk, 2.86; 95% confidence interval, 1.22 to 6.67).(12)

Hadjialiadis conducted a single center study to evaluate the incidence BOS after LTx.(21) BOS was diagnosed in 41.3% of the recipients (93 of 225 patients) at a median time since transplant of 4.2 years. SLT was associated with higher rates of BOS compared to BLT (49.3% vs 31.7%, respectively). After controlling for other patient characteristics, the type of transplant remained a significant predictor of the time to the onset of BOS in a multivariable regression model. The authors’ own institutional data also shows a greater incidence of BOS in SLT compared to BLT recipients.(20)

These findings above however are not consistent across all studies. Meyer and others, in UNOS database analysis of 2,260 LTx recipients with COPD, did not note any difference in the rate of development of BOS between SLT and BLT over a 3-year post-transplant followup period. (4)

Economic Evaluation and Societal Benefit

The cost-effectiveness of LTx versus medical therapy was studied by Anyanwu, who also compared SLT and BLT in their analysis.(22) The deduced that over a theoretical 15-year period LTx yielded mean benefits (relative to medical treatment) of 2.1 and 3.3 quality-adjusted life-years for SLT and BLT, respectively. Over the same duration, the average cost of medical care to those not getting transplanted was estimated at \$73,564, compared with \$176,640 and \$180,528 for SLT and BLT, respectively. The estimated costs per quality-adjusted life-year gained were \$48,241 for SLT and \$32,803 for BLT. Sensitivity analysis revealed that benefits could be maximized by improving the quality of life and lowering maintenance costs after transplantation.

The potential societal benefit from treating 2 patients with every donor lung block has also been systematically evaluated. Anyanwu studied lung donors from whom both lungs were used for transplant in the United Kingdom between April 1995 and December 1998 as reported to the UK Cardiothoracic Transplant Audit. (24) They noted that splitting of lung blocks resulted in an extra 0.8 survivors per donor block, 0.1 survivors free from rejection, and 0.6 symptom-free survivors at 1 year, compared to transplantation into one recipient. However, the rate of utilization of the lung block from one donor for 2 SLTs is not uniform. Speicher queried the UNOS database for all SLTs performed from 1987–2011. (25) They stratified donors into two groups: those donating both lungs and those donating only one. The authors reported 10,361 SLTs during this period, originating from 7,232 unique donors. Of these donors, only 3,129 (43.3%) had both lungs utilized. There was no significant increase in utilization over time. The authors noted the rarer blood groups and lower body surface area, among other predictors, were associated with non-utilization of the second lung.

Recommendations

Over the last decade, the relative proportion of BLTs as a part of all LTx operations has been progressively increasing while the number of SLT operations being performed annually is stable. (23) This trend likely reflects a general acceptance of some advantages of a bilateral transplant to the individual patient. However, in the face of conflicting, low-quality evidence, we cannot make a strong recommendation favoring one operation over the other when either is possible. Our institutional preference is to perform BLTs for the majority of our patients while still considering SLT on an individual basis for older patients with COPD or ILD, particularly if there is a significant difference in the perfusion to the two native lungs.

Future directions

Despite the lack of concrete evidence, there is almost no possibility of conducting a successful randomized trial that will compare SLT and BLT in the appropriate patient population. We anticipate that further analyses of registry data and statistical modeling studies will be important over the next several years in further elucidating the relative merits and demerits of SLT and BLT.

Acknowledgments

Grant Support

Varun Puri - NIH K07CA178120, K12CA167540-02 (Paul Calabresi Award)

References

1. Lau CL, Patterson GA. Technical considerations in lung transplantation. *Chest Surg Clin N Am*. 2003; 13:463–483. [PubMed: 13678308]
2. Puri V, Patterson GA. Adult lung transplantation: technical considerations. *Semin Thorac Cardiovasc Surg*. 2008; 20:152–164. [PubMed: 18707650]

3. Brown CR, Mason DP, Pettersson GB, Murthy SC. Outcomes after single lung transplantation in older patients with secondary pulmonary arterial hypertension. *J Heart Lung Transplant*. 2013; 32:134–136. [PubMed: 23085328]
4. Meyer DM, Bennett LE, Novick RJ, Hosenpud JD. Single vs bilateral, sequential lung transplantation for end-stage emphysema: influence of recipient age on survival and secondary end-points. *J Heart Lung Transplant*. 2001; 20:935–941. [PubMed: 11557187]
5. Meyer DM, Edwards LB, Torres F, Jessen ME, Novick RJ. Impact of recipient age and procedure type on survival after lung transplantation for pulmonary fibrosis. *Ann Thorac Surg*. 2005; 79:950–957. discussion 957–958. [PubMed: 15734411]
6. Pasque MK, Trulock EP, Cooper JD, et al. Single lung transplantation for pulmonary hypertension. Single institution experience in 34 patients. *Circulation*. 1995; 92:2252–2258. [PubMed: 7554209]
7. Meyers BF, Lynch JP, Trulock EP, et al. Single versus bilateral lung transplantation for idiopathic pulmonary fibrosis: a ten-year institutional experience. *J Thorac Cardiovasc Surg*. 2000; 120:99–107. [PubMed: 10884661]
8. Black MC, Trivedi J, Schumer EM, Bousamra M 2nd, van Berkel V. Double Lung Transplants Have Significantly Improved Survival Compared With Single Lung Transplants in High Lung Allocation Score Patients. *Ann Thorac Surg*. 2014
9. Chang AC, Chan KM, Lonigro RJ, et al. Surgical patient outcomes after the increased use of bilateral lung transplantation. *J Thorac Cardiovasc Surg*. 2007; 133:532–540. [PubMed: 17258594]
10. Force SD, Kilgo P, Neujahr DC, et al. Bilateral lung transplantation offers better long-term survival, compared with single-lung transplantation, for younger patients with idiopathic pulmonary fibrosis. *Ann Thorac Surg*. 2011; 91:244–249. [PubMed: 21172522]
11. Gammie JS, Keenan RJ, Pham SM, et al. Single-versus double-lung transplantation for pulmonary hypertension. *J Thorac Cardiovasc Surg*. 1998; 115:397–402. discussion 402–393. [PubMed: 9475535]
12. Gerbase MW, Spiliopoulos A, Roachat T, Archinard M, Nicod LP. Health-related quality of life following single or bilateral lung transplantation: a 7-year comparison to functional outcome. *Chest*. 2005; 128:1371–1378. [PubMed: 16162731]
13. Mason DP, Rajeswaran J, Murthy SC, et al. Spirometry after transplantation: how much better are two lungs than one? *Ann Thorac Surg*. 2008; 85:1193–1201. 1201 e1191–1192. [PubMed: 18355494]
14. Minambres E, Llorca J, Suberviola B, et al. Early outcome after single vs bilateral lung transplantation in older recipients. *Transplant Proc*. 2008; 40:3088–3089. [PubMed: 19010203]
15. Neurohr C, Huppmann P, Thum D, et al. Potential functional and survival benefit of double over single lung transplantation for selected patients with idiopathic pulmonary fibrosis. *Transpl Int*. 2010; 23:887–896. [PubMed: 20230541]
16. Nwakanma LU, Simpkins CE, Williams JA, et al. Impact of bilateral versus single lung transplantation on survival in recipients 60 years of age and older: analysis of United Network for Organ Sharing database. *J Thorac Cardiovasc Surg*. 2007; 133:541–547. [PubMed: 17258596]
17. Thabut G, Christie JD, Ravaud P, et al. Survival after bilateral versus single lung transplantation for patients with chronic obstructive pulmonary disease: a retrospective analysis of registry data. *Lancet*. 2008; 371:744–751. [PubMed: 18313503]
18. Weiss ES, Allen JG, Merlo CA, Conte JV, Shah AS. Survival after single versus bilateral lung transplantation for high-risk patients with pulmonary fibrosis. *Ann Thorac Surg*. 2009; 88:1616–1625. discussion 1625–1616. [PubMed: 19853121]
19. Anyanwu AC, McGuire A, Rogers CA, Murday AJ. Assessment of quality of life in lung transplantation using a simple generic tool. *Thorax*. 2001; 56:218–222. [PubMed: 11182015]
20. Cassivi SD, Meyers BF, Battafarano RJ, et al. Thirteen-year experience in lung transplantation for emphysema. *Ann Thorac Surg*. 2002; 74:1663–1669. discussion 1669–1670. [PubMed: 12440627]
21. Hadjiliadis D, Davis RD, Palmer SM. Is transplant operation important in determining posttransplant risk of bronchiolitis obliterans syndrome in lung transplant recipients? *Chest*. 2002; 122:1168–1175. [PubMed: 12377838]

22. Anyanwu AC, McGuire A, Rogers CA, Murday AJ. An economic evaluation of lung transplantation. *J Thorac Cardiovasc Surg.* 2002; 123:411–418. discussion 418–420. [PubMed: 11882810]
23. Yusen RD, Christie JD, Edwards LB, et al. The Registry of the International Society for Heart and Lung Transplantation: Thirtieth Adult Lung and Heart-Lung Transplant Report--2013; focus theme: age. *J Heart Lung Transplant.* 2013; 32:965–978. [PubMed: 24054805]
24. Anyanwu AC, Rigers CA, Murday AJ. Does splitting the lung block into two single lungs equate to doubling the societal benefit from bilateral lung donors? Comparisons between two single versus one bilateral lung transplant. *Transplant Int.* 2000; 13:S201–S202.
25. Speicher, PJ.; Ganapathi, AM.; Englum, BR., et al. Single lung transplantation in the United States; What happens to the other lung?. Oral Presentation at the 34th Annual Meeting of the International Society for Heart and Lung Transplantation; San Diego, California. April 10–13, 2014;

Key points

1. Single or double lung transplantation is often performed for end-stage emphysema or pulmonary fibrosis.
2. Single lung transplantation may maximize benefit to society by splitting the donor block.
3. Double lung transplant provides greater benefit to the individual patient.

Table 1

Gross evaluation of relative advantages of single lung transplant and double lung transplant based upon published literature.

Outcome parameter	Advantage SLT	Advantage BLT
Duration of operation	+	–
ICU and hospital stay	–	–
Early mortality	–	–
FEV1 improvement with LTx	–	+
QOL measures	–	–
Freedom from BOS	–	+
Long-term survival	–	+
Relative cost-effectiveness (individual perspective)		+
Maximum societal benefit	+	
High-risk recipient	–	+

Table 2
Summary of evidence comparing single lung transplant and double lung transplant operations.

Author	Study design	Source of Information	Number of patients	Indication for transplantation	Key findings	Potential for bias	Quality of evidence
Gammie (1998) ¹¹	Retrospective	University of Pittsburgh	57	Pulmonary hypertension	Similar survival after SLT or BLT	Yes	Low
Meyers (2000) ⁷	Retrospective	Washington University	45	Pulmonary fibrosis	Similar survival after SLT and BLT	Yes	Low
Anyanwu (2000) ²⁴	Retrospective	UK Cardiothoracic Transplant Audit	405	All	splitting lung blocks led to 1.8 extra survivors per donor block	Yes	Low
Force (2011) ¹⁰	Retrospective	UNOS Thoracic Transplant Database	3,860	Pulmonary fibrosis	Similar survival after BLT and SLT in multivariate and propensity matched analyses	Yes	Low
Meyer (2001) ⁴	Retrospective	UNOS Thoracic Transplant Database	2,260	COPD	BLT leads to longer survival in recipients younger than 60	Yes	Low
Anyanwu (2001) ¹⁹	Cross sectional questionnaire survey	Multiple center in UK	255	All	QOL better after BLT	Yes	Low
Hadjiiladis (2002) ²¹	Retrospective	Duke University	225	All	Reduced risk for BOS with BLT	Yes	Low
Anyanwu (2002) ²⁴	Statistical modeling	UK Cardiothoracic Transplant Audit	-	All	Cost per quality-adjusted life year gained lower with BLT	Yes	Low
Meyer (2005) ⁵	Retrospective	UNOS Thoracic Transplant Database	821	Pulmonary fibrosis	SLT leads to longer survival in recipient	Yes	Low

Author	Study design	Source of Information	Number of patients	Indication for transplantation	Key findings	Potential for bias	Quality of evidence
					younger than 60 younger than 60		Puri et al.
Gerbase (2005) ¹²	Prospective	University of Geneva	44	All	Similar exercise tolerance and QOL after SLT and BLT	Yes	low
Chang (2007) ⁹	Retrospective	University of Michigan	339	All	Better survival with BLT	Yes	Low
Nwakanma (2007) ¹⁶	Retrospective	UNOS Thoracic Transplant Database	1,656	All, 60 years old	Similar survival for SLT and BLT	Yes	Low
Mason (2008) ¹³	Retrospective	Cleveland Clinic	463	All	Spirometry weakly favors BLT over SLT	Yes	Low
Thabut (2008) ¹⁷	Retrospective	ISHLT registry	9,883	COPD	BLT provided survival advantage especially at <60 years of age	Yes	Low
Weiss (2009) ¹⁸	Retrospective	UNOS Thoracic Transplant Database	1,256	Pulmonary fibrosis	BLT superior to SLT in high-risk patients	Yes	Low
Neurohr (2010) ¹⁵	Retrospective	Ludwig-Maximilians University, Munich	76	Pulmonary fibrosis	BLT provided functional and survival advantage	Yes	Low
Yusen (2013) ²³	Retrospective	ISHLT registry	43,428	All	Longer survival after BLT	Yes	Low
Black (2014) ⁸	Retrospective	UNOS Thoracic Transplant Database	728	All	High LAS patients did better with BLT	Yes	Low