Single Versus Bilateral Lung Transplantation
Do Guidelines Exist?

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KEYWORDS

• Single lung transplantation • Double lung transplantation • Quality of life • Pulmonary fibrosis
• Emphysema

KEY POINTS

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

INTRODUCTION

Lung transplantation (LTx) has been accepted therapy for end-stage pulmonary disease for more than 2 decades. Lung transplant operations, unlike other solid organ transplants, are unique in that the donor block may be used for one recipient for a bilateral transplant or split to potentially benefit 2 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, but 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. This article examines the relative benefits and drawbacks of single versus bilateral LTx 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 because of concerns about contaminating the new lung with preexisting infection. Thus, this article excludes septic lung disease and accepts, for that population, the superiority of a bilateral operation. In addition, older patients with secondary pulmonary hypertension have anecdotally been considered preferentially for a bilateral transplant; however, Brown and colleagues[20] recently showed excellent short-term and intermediate outcomes in patients aged 65 years or older receiving a unilateral transplant. Otherwise, both single and bilateral transplants have been performed for other common indications including chronic obstructive pulmonary disease (COPD),[7] interstitial lung disease (ILD),[10] and primary pulmonary hypertension.[21] Single-center and registry-based studies have published comparative periprocedural, intermediate, and long-term outcomes after single and bilateral lung transplant[1,3,4,6,7,10–17,19,21,22]; however, no randomized trials or prospective, controlled studies have evaluated these two operations. In addition, the relative individual, societal, and

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Table 1
Gross evaluation of relative advantages of single lung transplant (SLT) and bilateral lung transplant (BLT) based on published literature

Outcome Parameter	Advantage SLT	Advantage BLT
Duration of operation	+	–
ICU and hospital stay	–	–
Early mortality	–	–
FEV_1 improvement with LTx	–	+
QOL measures	–	–
Freedom from BOS	–	+
Long-term survival	–	+
Relative cost-effectiveness (individual perspective)	–	+
Maximum societal benefit	+	–
High-risk recipient	–	+

Abbreviations: BOS, bronchiolitis obliterans syndrome; FEV_1, forced expiratory volume in 1 second; ICU, intensive care unit; QOL, quality of life.

economic implications of these approaches have been widely debated.[11,17]

EARLY OUTCOMES

Advocates of single LTx cite the simpler technical nature, the avoidance of a sternotomy, and the shorter duration of the procedure[22] as major advantages leading to improved immediate and perioperative outcomes. A registry database study of patients with ILD by Meyer and colleagues[10] 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% vs 77.1%). Survival was also significantly better with SLT than BLT at this early time point in those patients aged 50 to 59 years (early, 89.5% vs 81.7%).[10] In contrast, a smaller institutional study by Minambres and colleagues[22] showed that the 30-day survival was 81% in patients who underwent SLT, and 92% in patients who underwent BLT. 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.[4] A registry database study by Meyer and colleagues,[7] evaluating patients with COPD, also found no difference in 30-day mortality between SLT and BLT in patients up to 60 years of age. They did note a higher 30-day survival for SLT versus BLT (93% vs 78%); however, the patient population is from the 1991 to 1997 time period, when arguably the BLT operation was still being learned and perfected. In contrast, Chang and colleagues[12] evaluated a single-institution database and noted a better 3-month survival with BLT compared with SLT, and confirmed their findings in a multivariate analysis.

Other investigators have also compared commonly accepted measures of early postoperative outcomes and found no major difference between SLT and BLT. Minambres and colleagues[22] noted identical duration of postoperative ventilation (SLT, 32 hours; BLT, 29 hours) and intensive care unit 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 for the SLT and BLT (7.5 vs 10 days, respectively), length of stay in the intensive care unit (10 vs 16 days), and hospital stay (32 vs 52 days) were not significantly different.[3] Although 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

Spirometry, as measured by forced expiratory volume in 1 second (FEV_1) or FEV_1% predicted, is a key objective indicator of functional status in patients both before and after transplantation. Spirometry is strongly correlated with QOL in the lung transplant population.[11] Mason and colleagues[14] studied the relative impacts of SLT and BLT on FEV_1 at their institution. In 379 adult recipients, 6372 evaluations of postoperative FEV_1 and forced vital capacity (FVC) were analyzed using longitudinal temporal decomposition methods for repeated continuous measurements. FEV_1% predicted was better after BLT compared with SLT (65%, 58%, and 59% vs 51%, 43%, and 40% at 1, 3, and 5 years; $P = .3$). FVC measurements followed a similar pattern. In patients who had BLT, the posttransplant gains were more stable with fewer declines in FEV_1 compared with patients who had SLT, but FEV_1 measurements in patients after BLT did not reach double the values of SLT recipients. The differences in FEV_1 values between SLT and BLT were most pronounced in patients