



Size Matching in Adult Lung Transplantation – (still) an open question?

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Size Matching – the essentials

Introduction

- Lung transplantation is considered the gold-standard therapy for end-stage lung disease
- Because of donor shortages surgeons occasionally use size-mismatched donors
- Nevertheless, size matching is an important issue that affects outcome

How to assess lung size

- Chest perimeter ¹, chest radiographs ², planimetric measures,³ vital capacity, ⁴ computer tomography lung volume ⁵ and Total Lung Capacity ⁶ have been explored as potential variable to match the size of lungs between donor and recipient.
- Age, sex, ethnicity, recipient disease (obstructive vs. interstitial) and previous surgeries (e.g. lung resections) are also co-factors when estimating lung volumes.
- Predicted Total Lung Capacity (pTLC, calculated from a formula which incorporates height and sex) is probably the most frequently used surrogate marker of functional lung volume. However, pTLC might overestimate real TLC in patients with restrictive lung disease and CT-derived volumetric assessment might provide a more accurate estimate. ^{5 7}
- Traditionally, it has been suggested that a donor pTLC should be between 75% and 125% of recipient pTLC for bilateral lung transplantation (BOLT). ⁸ However, considerably larger lungs might be evaluated for patients with COPD who are candidates to single lung transplantation (SOLT).
- Most recent International Society for Heart and Lung Transplantation (ISHLT) Report ⁹ uses only height (as opposed to TLC, which includes sex and age) because height is the most informative variable. ^{10 11}

The effects of lung size on outcomes

- Oversizing might lead to atelectasis, retention of secretions (and infections)¹² while undersizing could cause pneumothorax, hyperexpansion of the lung (potentially leading to hemodynamic compromise or pulmonary hypertension)^{12 13}, primary dysfunction, bronchiolitis obliterans syndrome (BOS), poor survival.^{14 15} Any mismatch could also lead to anastomotic airway complications.¹⁶
- Data mainly from relatively small studies or ISHLT Report.
- Available studies suggest that oversized allograft have slightly better^{14, 17-19} or equivalent^{20, 21} short- and long-term outcomes.
- According to the ISHLT Report⁹ patients with COPD- or A1ATD-related lung disease (associated with increased TLC) as well as CF patients received lungs from taller donors, while patients with ILD received lungs from shorter donors.
- According to the same report⁹ male-to-female transplants were generally oversized while the opposite was true for female-to-male transplants (sex-matched transplants were generally well matched for size)
- Unadjusted 1-year survival is lower for recipient of undersized organs; when considering individual diagnoses, undersizing is associated with lower 1-year survival for COPD-, A1ATD and CF- patients, not for recipients with ILD.⁹
- The same was true for 5-year survival but interestingly the 5-year incidence of BOS was not different among groups.⁹
- The ISHLT Report⁹ also provides data on transplant patients mismatched by weight. Both 1- and 5-year survival are lower for recipients of undersized donors.

Management of size mismatch between donor and recipient

- The International Society for Heart and Lung Transplantation Report⁹ does not include data regarding donor lung resection during transplant
- Therefore, management strategies vary according to different surgeons and centers
- For living-donor lung transplants usually a 2-lower-lobe graft is implanted after bilateral pneumonectomy. However, in case of predicted functional insufficiency of the graft modified techniques like native upper lobe-sparing lobar lung transplantation or right-to-left inversion (whereby a RLL is implanted in place of a LLL) might be used to solve this problem.^{22 23} Additionally, single-lobe transplants are also possible.²²
- For deceased-donor lung transplantation ideally the whole lung can be transplanted. However, scenarios of uni- or bilateral lobar transplantations or, more frequently, wedge (and potentially lobar) resections are possible.^{24, 25} While an anatomical resection can be performed before or after implantation a lobar transplantation is usually decided in advance.
- Single-lung transplantation is also possible and in a recent case series, 39% of the Author's single-lung transplants have resulted from aborted double-lung transplants.²⁶
- Finally, if graft edema/inflammation is believed to be (at least partially) responsible for the mismatch (or coagulopathy ensues) decision can be made to delay chest closure and re-assess after 48-72h.²⁷ At this point, a surgical resection can be performed or the chest

can be eventually closed. This procedure, however, results in a higher incidence of infections.²⁷

Example Case

- 27-year old female with past medical history of cystic fibrosis, s/p bilateral orthotopic lung transplantation ~4 years prior
- Chronic allograft dysfunction → listed for repeat transplantation
- Small patient; 152cm, 53kg
- Preoperative PFT's: TLC 4.26L
- Complex resection, performed on cardiopulmonary bypass
 - 11 units packed red blood cells, 5 units plasma, 4 units platelets, 4 units cryoprecipitate
- Surgeons electing to leave chest open citing graft size plus coagulopathy
- Grafts functioning well, able to tolerate weaning of ventilator settings
- Brought back to operating room post-operative day 3 for chest closure
- Transesophageal echocardiography utilized to monitor for cardiac effects of closure
- Wedge resections performed in left upper lobe, right middle and upper lobes
- Tolerated chest wall closure without issue, maintained on ICU ventilator throughout

Conclusions

- Size matching is an important (but often underestimated) issue in lung transplantation and affects outcome
- Because of organ shortages, sometimes surgeons have to accept and transplant size-mismatched organs
- pTCL, even if not perfect, is a simple and frequently used method to match donor and recipient lungs
- There are a variety of techniques that can be used should a mismatch occur and the anesthesiologist should be familiar with the process.

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