Lung Volume Predicts Survival and Diaphragm Plication on ILD Patients Undergoing Transplant Using Frustum Model

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Introduction

Lung transplantation is a viable treatment option for patients presenting with end-stage lung disease. Patients with interstitial lung disease (ILD) present with respiratory deficiency and is associated with substantial morbidity and mortality. Although lung transplantation is a therapeutic option, the United Network for Organ Sharing (UNOS) reports that the survival rate after transplant is lower for patients with ILD compared with patients with other pathologies such as chronic obstructive pulmonary disease (COPD).

For optimal outcomes, size matching between donor and recipient is an important consideration. Currently the standard method used in determining predicted lung volumes is by nanograms based on age, sex, and height. Implantation of larger allografts than the recipient predicted lung volume is preferred and is achieved in patients with obstructive lung disease. However, this is more difficult in patients with pulmonary vascular disease or ILD.

Learning Objective

To validate the frustum model for lung volumes in patients with interstitial lung disease (ILD) undergoing lung transplantation, and to test whether lung size by frustum model is associated with cumulative survival advantage and need for diaphragm plication following lung transplant.

Methods

Retrospective observational study consisting of patients seen in the University of Texas Southwestern-affiliated hospitals during the period from May 2010 to May 2016.

Patients receiving bilateral or single lung transplant for ILD with available pre and post operative CT scans were included.

Volume of a truncated cone (frustum) was used to calculate total lung volume with pre and post-operative CT and XR chest PA closest to surgery time.

Frustum equation: $\mathbf{V = \frac{1}{3}\pi h(R_1^2 + R1R2 + R_2^2)}$

Patients were stratified by post/pre transplant lung volume ratio >1 or ratio ≤ 1.

Outcomes:

- Survival – Cox proportional hazards regression model
- Diaphragm plication – Multivariate logistic regression analysis

Methods

Height = distance from the clavicle to the diaphragm on chest XR
Radius 1 = radius created by first rib on sternum by CT
Radius 2 = radius created by last rib before diaphragm by CT

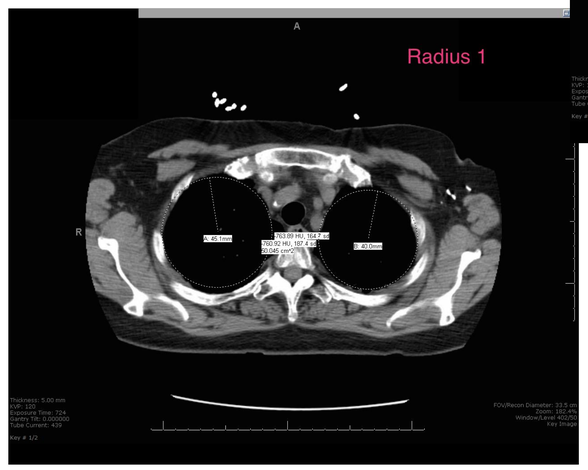

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Figure 1: CT CHEST, first radius

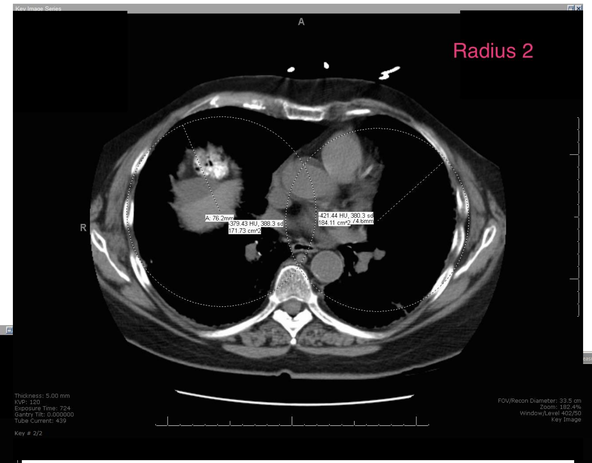


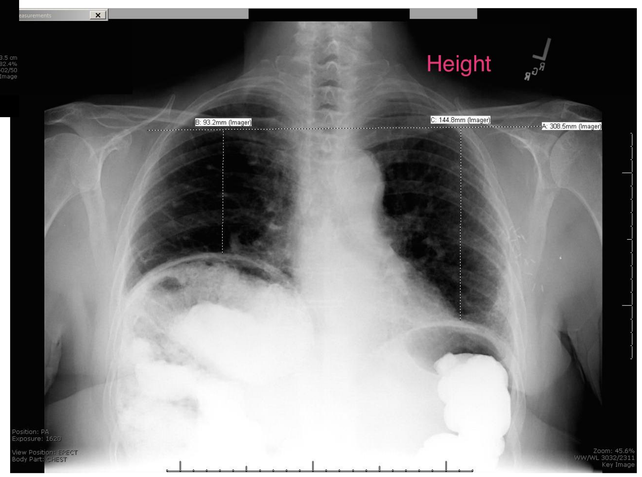
Figure 2: CT CHEST, second radius

Frustum equation: $\mathbf{V = \frac{1}{3}\pi h(R_1^2 + R1R2 + R_2^2)}$

Total volume = left + right lung

Ratio: post/pre-transplant lung volume

Figure 3: AP XR, height



Results

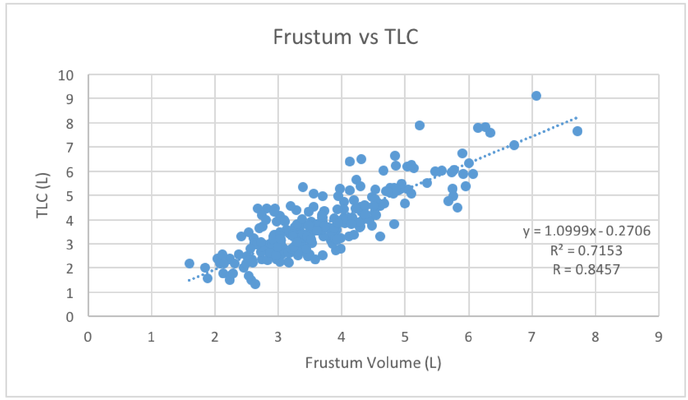


Figure 4: Scatter plot, correlation coefficient

180 patients who presented to the University of Texas Southwestern-affiliated hospitals were evaluated.

Of the 180 patients sampled:

•39 (22%) had lung volume ratio ≤1
•141 (78%) had lung volume ratio > 1

- To validate the frustum model, Pearson Correlation Coefficient assessed correlation between plethysmography TLC and frustum volume (n =251, r=.85, p <.01)
- Multivariate analysis for diaphragm plication included lung ratio, BMI, and smoking status. Lung volume ratio was a significant predictor of diaphragm plication (ratio >1 OR 7.19, p <.05)
- Multivariable Cox regression model for survival included lung ratio, diabetes, dyslipidemia, re-intubation, and post-operative pneumonia. Lung volume ratio (ratio ≤1HR 1.79, p <.05) and re-intubation (HR 3.43, p<.01) were significant predictors

Conclusion

The frustum model is a valid method for evaluating lung volumes in transplantation. The study suggests that lung volume confirms previous observations of a survival advantage to larger donor size in ILD. However, larger lung size may require diaphragm plication.

References

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