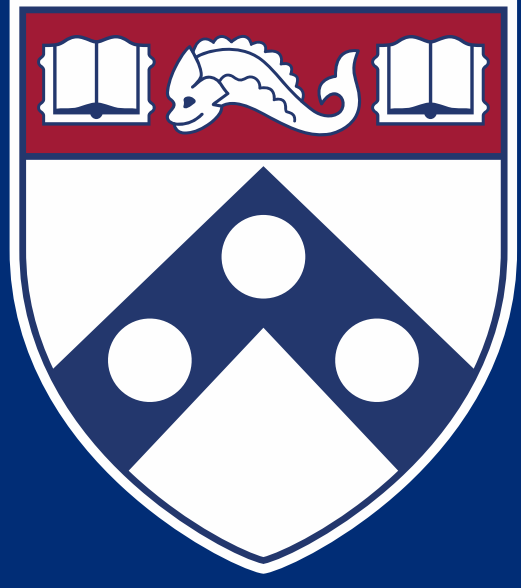
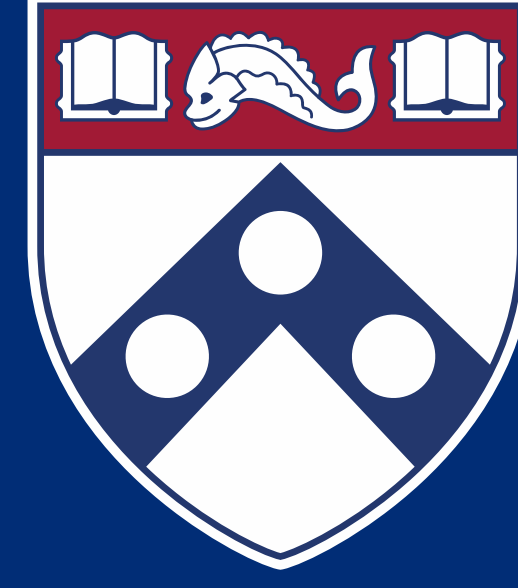




Enhancing Surgical Planning and Intraoperative Support for Anatomic Lung Resections Using Three-Dimensional Reconstructive Technology



University of Pennsylvania; Division of Thoracic Surgery
Katherine O. Welch, Kelly A. McGovern, Taine T.V. Pechet, Sunil Singhal, Doraid Jarrar
Supported by T32-CA251063-05 from the National Institutes of Health

Introduction

- Randomized controlled trials show sublobar resections are superior to lobectomy for small peripheral non-small cell lung cancers^{1,2}
 - Preserve lung function while maintaining oncologic standards
- Unfamiliarity with segmental anatomy, including aberrant vasculature, might hinder adoption of sublobar resections outside clinical trials
- Hypothesis:** 3D reconstruction may allow for better preoperative planning compared to computed tomography (CT) scans alone
- Aim:** a pilot study to explore the feasibility and utility of incorporating 3D reconstruction into operative workflow and intraoperative decision-making in patients undergoing sublobar resection

Methods

- 13 patients selected for sublobar resection based on lesion size and location
- Modeling software (Materialise, Leuven, Belgium) was used to create 3D reconstructions of lung anatomy based on thin-cut preoperative CT scans
 - Includes broncho-vascular anatomy, segmental planes, and 1- and 2-cm margins around the lesion
- Surgeons decided surgical plan based on CT imaging, then reviewed 3D reconstruction pre- and intraoperatively and documented any change to surgical plan
- All cases were recorded, and clinical data were collected

Mean age (years ± SD)	65 ± 12
Sex	
Female	85% (11/13)
Male	15% (2/13)
Mean Lesion Size (cm)	1.5 ± 0.8
Lesion Location	
Left Upper Lobe	47% (6/13)
Left Lower Lobe	15% (2/13)
Right Upper Lobe	23% (3/13)
Right Lower Lobe	15% (2/13)

Table 1. Demographic and clinical characteristics of study patients

Results

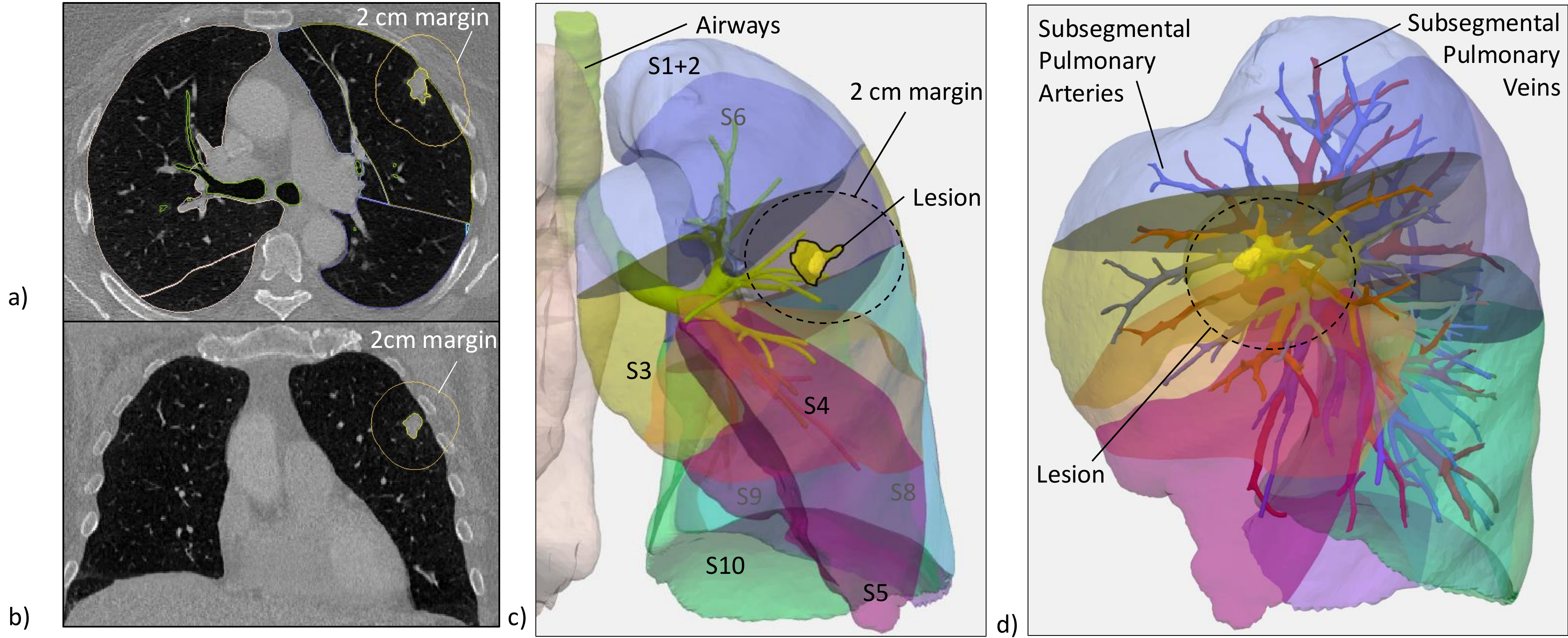


Figure 1. (a-b) Preoperative CT scan shows a lesion within S3 segment. (c) Anterior view and (d) lateral view of 3D reconstruction show 2-cm margins extending into S4 segment, prompting expansion of resection field from segmentectomy to lobectomy.

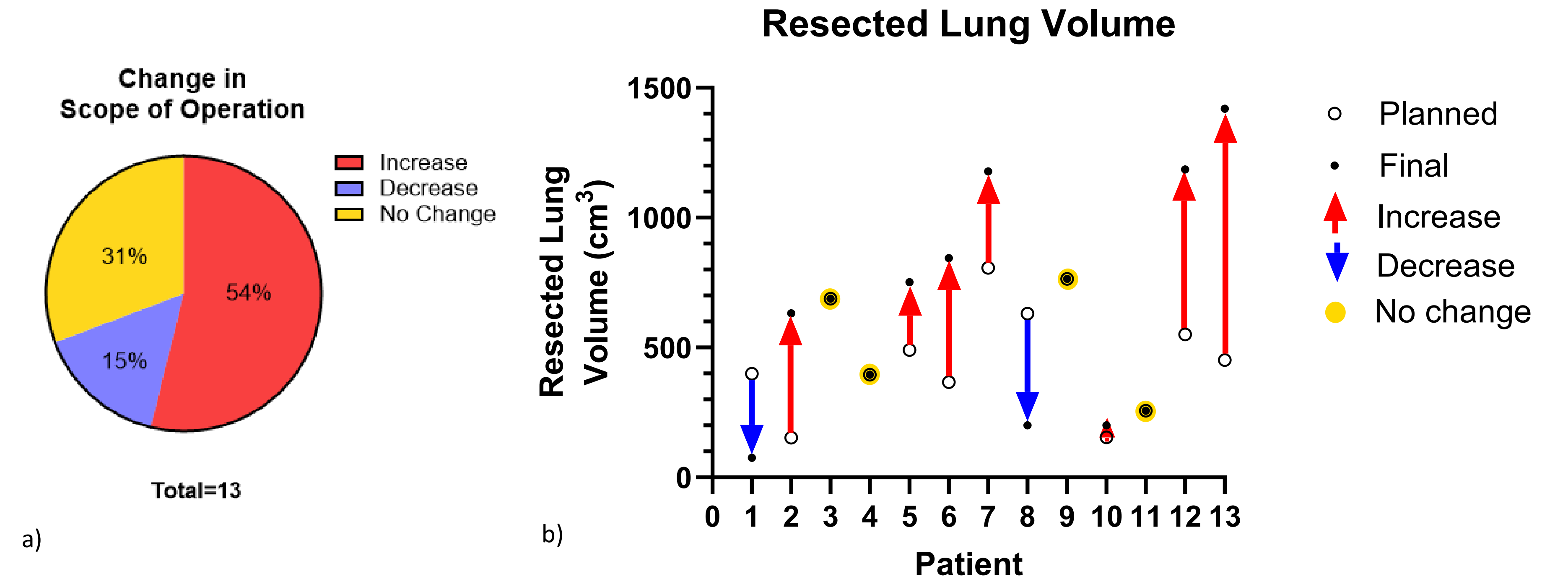


Figure 2 (a) Pie graph showing changes in operative scope. Scope increase included greater number of resected segments or lobectomy. Scope decrease included fewer resected segments or a wedge resection. (b) Dumbbell plot showing the final amount of lung resected compared to planned based on 2D CT scan for each patient.

Results

- Lesion Characteristics**
- 47% (6/13) in left upper lobe (S3 or apical tri-segment)
 - Mean tumor size on CT: 15±7.5mm
 - Mean tumor size on final pathology: 18.4±7.6 mm
 - Mean margin of 26.4 mm
- Changes to Operative Plan based on 3D Reconstruction**
- 69% (9/13) of patients had a change in their final operation
 - 54% (7/13) had increase in scope (segmentectomy→lobectomy or larger segment)
 - 15% (2/13) had decrease in scope (segmentectomy→wedge or smaller segment)
 - 31% (4/13) had no change in their planned resection
 - Mean change in planned versus actual lung volume resected: +191 cm³
- Delineating Operative Anatomy with 3D Reconstruction**
- Identified aberrant vascular anatomy in 38% of cases (5/13)
 - Predicted inadequate margins with segmentectomy only in 23% of cases (3/13)
 - Average number of intraoperative reviews of 3D reconstruction: 2.8

Conclusion

- 3D recon was easy to implement and incorporate into intraoperative workflow
- Useful for predicting margins and visualizing anatomic variants to understand the practicality of sublobar resection
- Future directions: implementation of intraoperative overlay of 3D reconstruction images during robotic resections.

References

1.Saji, H. *et al.* Segmentectomy versus lobectomy in small-sized peripheral non-small-cell lung cancer (JCOG0802/WJOG4607L): a multicentre, open-label, phase 3, randomised, controlled, non-inferiority trial. *The Lancet* **399**, 1607–1617 (2022).
2. Altorki, N. *et al.* Lobar or Sublobar Resection for Peripheral Stage IA Non-Small-Cell Lung Cancer. *N. Engl. J. Med.* **388**, 489–498 (2023).