Editorial Commentary

Anatomic wedge resection

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The principles of lung cancer surgery—a complete resection with negative margins and lymphadenectomy—have remained consistent over the last century. In the 1930s, pneumonectomy was the standard of practice in all cases. In the 1940s and 1950s lobectomy evolved as an alternative to preserve lung and reduce perioperative mortality (1). This practice persisted for half a century as lobectomy solidified its gold-standard status in 1995 with randomized data supporting it's superiorly to sublobar resection (2). In recent years, however, the practice of pulmonary resection has undergone a renaissance of minimally-invasive approaches and ongoing efforts to reduce the amount of lung tissue resected. For patients with early-stage non-small cell lung cancer—tumors less than or equal to 2 cm (clinical stage 1A, cT1aN0 and cT1bN0)—pulmonary segmentectomy has been shown to be non-inferior to lobectomy. Upending a decades-long dogma that pulmonary lobectomy confers greater disease-free and overall survival, contemporary randomized data demonstrates comparable, if not superior, oncologic outcomes after segmentectomy in appropriately selected patients with early-stage lung cancer (3,4).

With some controversy and variable interpretation of the data, the CALGB 140503 Alliance trial also reported that non-anatomic wedge resection was equivalent to segmentectomy. Practically, wedge resections made up a large portion of the reported United States registry data for sublobar resections (what American surgeons were actually doing) and therefore, were included in the study. In this context, Bin Qiu, MD and colleagues have posited a lesion-based approach to surgery termed, "anatomical partial lobectomy" (APL). The authors are congratulated for their recent publication of their single-center experience with APL in 3,336 patients in the *Journal of Thoracic and Cardiovascular Surgery* (5). In their retrospective review, the authors report excellent operative and perioperative outcomes with short operative times, acceptable nodal sampling, low postoperative morbidity (10.8%) and no 30-day mortality. These data support the notion of APL as a feasible and safe operation. As expected with new approaches and procedures, the authors observed improved outcomes with increasing surgical experience, suggesting a learning curve to APL.

Traditionally, an anatomic segmentectomy is defined as removal of a single or multiple parenchymal lung segments together with their corresponding artery, vein, and bronchus. Alternatively, APL defines the surgical boundaries of resection based on a tumor-specific location and margin rather than anatomical intersegmental planes. The definition of APL, however, is somewhat oblique, as APL includes traditional segmentectomy, as well as extended or combined segmentectomies. Further, the authors describe subclassifications of APL as intentional or passive and simple versus moderate or complex. All of this is rather confusing and it is difficult to easily determine whether all patients are undergoing a unique procedure, or simply undergoing traditional segmentectomy. Conceptually, however, the authors have developed a novel approach to lung cancer surgery that is intuitive and logical—in a generalized sense, APL is like performing a targeted "anatomic" wedge resection.

In the methods section, the authors describe the perioperative components of APL. Preoperative planning is initiated with three-dimensional (3D) reconstruction of chest imaging, allowing for appreciation of spatial relations of the vascular and bronchial structures adjacent the target lesion. A safe margin distance is established by superimposing a spherical safety distance from the target lesion on the proposed parenchymal landscape. Lastly, once the parenchymal borders of resection have been established, the draining artery, vein, and bronchus are identified, thereby, completing the planned partial lobectomy. For clarity, the authors include a link to a video review of their preoperative process in the manuscript.

It must be noted that not all surgeons will have access to 3D imaging, which limits the generalizability of APL. Equally, alternative mapping techniques using 3D imaging, such as virtual-assisted lung mapping, have already be suggested (6). In this method, navigational bronchoscopic dye marking is performed to define the resection margin, which is then used to verify and optimize a subsequent 3D map for operative guidance. This type of mapping, however, is marred by its cumbersome process of two anesthetic events and imaging processes, as well as a loss of accuracy when targeting deep nodules (6).

In the operating room, the parenchymal "cutting plane" does not follow intersegmental borders, but by the predefined tumor margin distance based on deflation-inflation demarcations. One observation is that perhaps this demarcation is the same anatomy as the intersegmental plane for the majority of patients. In either case, the authors are commended for their focus on and assurance of an appropriate margin—a concept that is not often well defined in modern surgical lung cancer trials. The authors report that the margin is established on a totally deflated lung and report a mean distance of 2.1 cm. Additionally, I applaud the authors for the assurance of an appropriate margin by reoperation when required. Fortunately, this was only necessary in two patients in the entire cohort. These data are ostensibly critical to assessment of longer-term outcomes and position this patient cohort appropriately for further analysis. As the authors admit, their publication mainly focuses on the technical operative experience and early postoperative outcomes of APL. While important to establish as feasible and safe, the critical question for APL will be the long-term oncologic outcomes, including disease-free and overall survival. As the authors acknowledge, long-term data is critical to assess whether APL's limited, margin-based approach is comparable, or at least, non-inferior to traditional segmentectomy. Conceptually, it will also be interesting to see if small millimeter differences in margin distance contribute to disease recurrence. The authors are well positioned to help clarify this question. This said, margin distance essentially defines lobar versus sublobar resection, of which comparative trials have demonstrated relative parity of outcomes, such that a difference based on millimeters would be surprising.

Importantly, the APL method can be approached in a minimally-invasive fashion. In their cohort, the vast majority of patients underwent a minimally-invasive operation (96%) of which half were completed via a single-port approach. Conversion to thoracotomy was only performed in seven patients (0.2%). Non-planned reoperation occurred in nine patients (0.27%).

Whereas the majority of surgeons perform parenchymal division during sublobar resection with a surgical stapler, the cutting plane for APL is performed either by cautery, stapling, or a combined approach. The authors advocate for the later as cautery is able to preserve lung morphology without significantly increasing the rate of postoperative air-leak. However, the authors reported an overall air-leak rate of 4.9% making up approximately half of the overall complications. Further, the median chest tube duration was 4 days, likely due to inpatient chest tube dwell time for air-leak. Given the reduced parenchymal resection of APL, it is anticipated that these patients would be able to achieve a more rapid discharge and recovery after surgery. The role of cautery versus surgical stapling for APL remains an open question and point of clarification, as surgeons may be reluctant to adopt the method over the risk of postoperative air-leak.

An assessment of intermediate and long-term lung function is also welcomed in future studies. While lung preservation is theoretically satisfying, both of the segmentectomy trials mentioned previously reported fairly minor differences in postoperative pulmonary function post lobectomy and segmentectomy: only a 2–3.5% difference. Anecdotally, many surgeons observe superior patient respiratory function after segmentectomy, particularly in the early postoperative phase. Perhaps we are measuring postoperative pulmonary function incorrectly and should consider more specific measures such as cardiopulmonary exercise testing or 6-minute walk test to tease out a more accurate difference; at least from a research perspective.

Certainly, however, we are witnessing a diminishing return of preservation—from pneumonectomy to lobectomy to segmentectomy to wedge resection—and at some point, there likely isn't much clinical difference in terms of respiratory recovery.

The patient demographics in this study reveal a somewhat heterogeneous population and therefore, the technique and outcomes may not translate to all populations. The majority of the patients had favorable pathology, including minimal invasive carcinoma, or *in-situ* disease. Of the invasive patients, the majority were adenocarcinoma. The fact that 67% of patients were Asian, female, non-smokers, prompts the question of whether these patients had epidermal growth factor receptor (*EGFR*) mutations. Although this study focused on early-stage disease, recent trials have demonstrated improved outcomes for *EGFR*-mutant patients with later-stage disease with the use of adjuvant targeted therapy (7). Understanding the genomic/mutational status of lung tumors will likely play an expanding role in early-stage lung cancer in the future.

In conclusion, this study reflects a maturation of the APL procedure in an experienced center. The data reports a large volume of consecutive patients with excellent surgical and early postoperative outcomes (superior to those in recent segmentectomy trials), including limited morbidity and no 30-day patient mortality. By assuring a mean 2 cm margin distance, negative N1 status at time of surgery, and an adequate lymph node dissection, the authors are well positioned to report on longer-term outcomes such as disease-free and overall survival. APL may be considered an "anatomic" wedge resection. Given that this technique plans for and is dependent on margin distance, it is well positioned for comparable oncologic outcomes to traditional segmentectomy for early-stage lung cancer and will potentially be added to the armamentarium of standard approaches to lung cancer surgery.

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Footnote

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