Editorial

Confronting the fundamental challenges of airway surgery: a paradigm shift is practically upon us

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Video assisted thoracic surgery (VATS) for tracheal and bronchial pathology remains one of the great technical challenges in thoracic surgery. Dr. Li *et al.*'s paper and accompanying video succinctly articulates and displays how VATS is feasible in mid-tracheal lesions. Due to the rarity of tracheal pathology, most thoracic surgeons are deprived of the opportunity to master any one technique or modality. The authors' conclusion supports this view: "*it (tracheal resection) remains a highly challenging procedure for most medical teams*." (1).

After going back and re-reading many of the papers and conversations regarding airway resections, perhaps we can reinterpret the author's conclusion to suggest that it is the pathology that is the underlying "challenge" rather than the resection or its modality.

From the author's video, there is clear evidence of a highly precise and attentive surgical technique with a fundamentally strong comprehension of VATS. Unfortunately, VATS for airway pathology is very cumbersome and technically challenging approach that prevents most thoracic surgeons from even attempting it. The very paucity of VATS articles on airway disease supports this assertion (while simultaneously affirming Dr. Li's surgical abilities).

The underlying difficult nature of the pathology and ability to completely resect it, creates great challenges and limitations even for traditional open approaches. Dr. Hermes Grillo, unquestionably one of the greatest surgeons and teachers of airway surgery, has admitted as much: "*In so far as the problem of whether it is worth doing a resection if there is a positive margin… you have no option. In that sense, you have reached that point, and at that point you have to stop. Early on we did not stop, and you can see what the mortality was. However, we do know that death from airway obstruction is a wretched and miserable death….*" (2). This surgical tipping "point" lead to the allowance of a permissible positive surgical margin with the understanding that post-operative radiation would be required.

Technically, the challenges of airway resection have been the extent of longitudinal spread, with tumors less than 4 cm in length generally considered resectable (3,4). Morbidity and mortality factors usually relate to tracheal devascularization or excessive anastomotic tension, which traditionally explained the decision to accept residual microscopic disease to avoid excessive tracheal resection (4). There are rare instances when tracheal resection up to 6 cm in length may be considered, but then other maneuvers are required including bilateral hilar release, cervical tracheal mobilization, suprahyoid laryngeal release, and division of the inferior pulmonary ligaments (3,4).

Traditionally a posterolateral thoracotomy is an effective option, but to gain significant length a median sternotomy approach is preferred for improved exposure and ability to perform bilateral release maneuvers if required (5). This is one of the more significant issues limiting the benefits of a minimally invasive VATS approach despite its smaller 3–4 cm access incision in the anterior axilla as it only provides a unilateral access to the thorax.

Confronting the fundamental surgical limitation is that the pathology has dictated the possibility, or lack thereof, for airway surgery by limiting the resection.

What if this does not always have to be the case? Then the fundamentals as we know them could be altered to favor the surgeon and the patient. The future fortunately has two developing opportunities that may change this: robotics and tracheobronchial 3D printing.

Robotics provides all the added benefits of a minimal invasive procedure, while allowing for superior 3D visualization and 360-degree wristed instrumentation. These added benefits provide the surgeon with a far broader ability to sew and dissect in challenging areas of the thorax, especially the mediastinum. In addition, the newer robotic platforms allow for greater instrument flexibility with interchanging instruments, including the camera, so that they can be placed in any port in either hemithorax all during the same operation.

At the forefront of this robotic airway evolution is Dr. Richard Lazzaro, who has applied robotics for both benign and malignant diseases. Dr. Lazzaro's work is transformative in that its goals are to create a technique that is simultaneously straight forward, safe, and reproducible thus allowing for other robotic thoracic surgeons to perform it at their home institution (6).

Even with benefits of an evolving fantastic new instrument like the robot, surgeons remain limited by resection length and positive margin. What if we could alleviate this restriction through the application of a bioprosthetic airway created by 3D printing? This would allow entire segments of trachea and/or bronchus to be removed with negative margins and no limitation on length. In oncological terms, this could potentially provide a 57% increase in 5-year survival for squamous cell carcinoma while eliminating the need for adjuvant radiation (2).

This work is already underway by Dr. Faiz Bhora and his colleagues, who demonstrated feasibility of airway bioprosthetic in a live porcine model. Their platform is capable of producing recipient-specific tracheal grafts at a clinically relevant scale and speed. In addition, they demonstrated that safe and clinically used material can be processed to create customized anatomically precise tracheal grafts. These outstanding initial results will help shape reconstructive surgery in both adult and pediatric populations with congenital and malignant disease processes (7,8).

There is no question that Dr. Li is correct that airway disease remains a surgical challenge, but our patients' future looks extremely bright as technology fundamentally reshapes how we approach this disease process.

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Footnote

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