



Non-intubated uniportal robotic-assisted thoracic surgery: the future of thoracic surgery?

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It is a great privilege and honor to be invited to discuss the future of thoracic surgery, that is, the non-intubated, uniportal robotic thoracic approach. In past decades, cancer burden worldwide has substantially increased, among which tracheal, bronchial, and lung (TBL) neoplasms were estimated to be the most significant tumor-related factors affecting human health and longevity (1). Surgical management is the most effective and precise method for the radical treatment of these kinds of thoracic tumors, encompassing both lesion resection and anatomical reconstruction. At present, thoracic operations include traditional thoracotomy, video-assisted thoracic surgery (VATS) and robotic-assisted thoracic surgery (RATS). VATS and RATS are considered as the most minimally invasive methods. Compared with typical three-port VATS and RATS, procedures through a single port (uniportal) are increasingly appealing to patients and surgeons due to potentially less pain postoperatively, and higher satisfaction with respect to the least number of incisions made.

When it comes to an operation, an excellent anesthesia provides the essential prerequisite for patients to tolerate the surgery smoothly. In more recent times, anesthesiologists have preferred to apply non-intubated anesthesia, as

opposed to an intubated method, to patients when performing thoracic surgeries. Non-intubated anesthesia is well-described for thoracic procedures, including lung biopsies, lung volume reduction surgeries, anatomic lung resections, and even tracheal resections and tracheoplasty, as well as sleeve resections. Prior study has indicated, on the pathophysiological aspect, that it is likely to maintain not only a reduction in inflammatory markers, including lower white blood cell counts, interleukin-6 and interleukin-8, and higher lymphocyte and natural killer cells, but a lower level of biomarkers of adrenal stress like fibrinogen and cortisol (2). Our team have previously reported the efficacy of non-intubated VATS and RATS (3,4), which simplified procedures without the interference of endotracheal tubing, reduced the unstable SpO₂ during the operations, allowed for better surgical fields for airway/vascular anastomosis, and reduced perioperative complications and shortened hospital stay. As a specialist in robotic and thoracic surgery, Dr. Ott (5) commended and thought highly of the technical innovation and the incremental value to the patient, as well as suggested concerns over RATS adoption hurdles.

Gonzalez-Rivas *et al.* (6) took the lead in adapting the Davinci Xi[®] to a pure uniportal RATS approach using

robotic staplers, performing most types of lung resections, including complex resections, whilst achieving satisfying outcomes. The authors additionally applied RATS to resect and reconstruct the trachea and airway, demonstrating that RATS has the ability to overcome the incongruity between dominant and non-dominant hands, as well as being able to avoid micro tremors of the hands. Fine anastomosis of the trachea and blood vessels can be achieved even in hard-to-reach spaces, such as the deep mediastinum or narrow interstitial gaps with strange angles. Additionally, RATS, as a remote-control technology, is able to protect surgeons from infection by patients with highly contagious diseases, as well as provide timely and effective treatment. To a certain extent, long-distance surgical consultation can be realized as long as the operating end and the specific robotic arms are matched through the network, a principle conducive to the promotion and redistribution of advanced medical resources. Especially with the global outbreak of COVID-19 with its travel restrictions, the ability to consult and operate remotely is even more compelling.

Despite of the achievements made by RATS in the management of thoracic disease, current research has not demonstrated that pure RATS is more advantageous than non-intubated uniportal VATS (7). RATS additionally carries the potential of prolonging the learning curve for junior surgeons. Once this learning curve is optimized, the learning gains for junior thoracic surgeons will increase, which may make it feasible to implement RATS whilst simultaneously reducing surgical staff. Our team proposes to upgrade the general RATS system, in combination with the latest technologies, to transform it into non-intubated uniportal RATS system. It is thought that the combination of the current optimal method of anesthesia with the latest surgery modality would be expected to achieve excellent results. However, there are minimal studies focusing on non-intubated RATS, let alone the combination with a uniportal approach. We believe that the non-intubated uniportal RATS approach would be worth trying in absence of established data. Since the technique of spontaneous breathing anesthesia and RATS are proved matured enough, it is time to pioneer a novel operational protocol for thoracic surgery. Surgeons and researchers are implored to carry out relevant studies, including wedge resection, segmentectomy, lobectomy and tracheal/carinal/airway reconstruction, etc., to support the advancement of this technique.

In terms of the management of complications, RATS may be better at dealing with avoiding neurovascular

injuries, but it may not be satisfactory for acute massive bleeding and finding bleeding sites that require conversion to thoracotomy. In our experience, emergent airway manipulation will also be a technical challenge intraoperatively. As to the application, a higher-level robotic surgical system, an anesthetist good at non-intubated airway management and thoracic surgeons who are expert in uniportal RAST are indeed needed. There are few medical centers that can meet the above conditions at this time. Social factors such as economic benefits, ethical arguments, as well as patients' concerns, have also contributed to the limitation of the application and promotion of non-intubated uniportal RATS. Although the introduction of new technologies and procedures have been met with encouraging preliminary results, in consideration of safety, some researchers believe that the indications should still be strictly controlled for select, target patients (8). As the learning curve is further developed upon in the broader literature, the outcomes of uniportal RATS in more generalized hands will tell whether this concern is appropriate or excessive.

In conclusion, though the widespread implementation of uniportal RATS is likely to be seen in the near future of thoracic surgery, it remains unoptimized in many aspects. Primarily, surgical protocols need to be standardized, the learning curve developed, and surgical materials simplified so that the procedure can be as efficient and efficacious as possible.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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