



Minimally invasive carinal reconstruction— is less really more?

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The phrase “less is more” was first used in the poem ‘Andrea del Sarto’ (1855), written by the English poet and playwright Robert Browning. This expression had been later adopted by members of the Bauhaus movement, who advocated minimalism in art, design and architecture. The assumption of these artists was that less complicated things are often better understood and all unnecessary decoration should be omitted.

The evolution of minimally invasive thoracic surgery started with Hans Christian Jacobaeus who fixed a light source to the distal end of an endoscope at the beginning of the 20th century and thus performed pneumolysis in patients suffering from tuberculosis (1). In the past decade, minimally invasive approaches have gained increasing importance in thoracic surgery. This development was accompanied by numerous innovations in surgical instruments, stapling devices and camera systems. For anatomic lung resections, video-assisted thoracoscopic surgery (VATS) has become the standard approach. It is superior to thoracotomy due to smaller incisions, decreased postoperative pain, shorter length of hospital stay, decreased chest tube output and duration, decreased blood loss, better preservation of pulmonary function and earlier return to normal activities (2). Lately, VATS techniques have been refined and experienced centers can now even perform extended resections such as bronchial or bronchovascular sleeve resections by VATS. To the best of our knowledge, the highest level of evidence for minimally invasive

anatomic sleeve resections was published by Xie and colleagues. The authors could demonstrate in a propensity score matched analysis that VATS sleeve resections are feasible and outcomes are comparable to sleeve-resections requiring thoracotomy. Importantly, operative times, complication rates and 90-day mortality rates were similar in both groups (3,4). Even though VATS sleeve resections might be comparable in experienced hands the questions remains if this is also true for VATS carinal resections.

Surgery including the carina is considered a technically demanding procedure based on the extent of the resection and the need for an often complex airway reconstruction (usually a neocarina or two anastomoses (a tracheo-bronchial end-to-end anastomosis and an end-to-side bronchial reinsertion). It is generally accepted that this procedure requires a high surgical expertise. In addition to technical challenges, patient selection and perioperative patient management are important factors to avoid often detrimental complications in this patient group.

One of the founding fathers of carinal resection was Osler Almon Abbott who reported four cases of a right pneumonectomy with carinal resection at Emory university in the 1950s (5). This initial expertise was expanded by Hermes Grillo and his publication of 36 carinal resections and primary reconstructions performed between 1962 and 1981 at the Massachusetts General Hospital (MGH) with an operative mortality of 13% (6). The practice of carinal resections grew and by 1999 MGH airway surgeons

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were able to publish a series of already 143 cases. Despite this growing experience, operative mortality for primary reconstructions remained unchangingly high at 12.7% (7). Modern series have managed to reduce perioperative mortality to 7–9% (8,9). It is clear that minimally invasive approaches can only be adopted if they do not come at the cost of increased perioperative risks.

Recently, several case reports of VATS carinal reconstructions have been published mainly by Chinese surgeons (10,11).

In their article “Minimally invasive carinal reconstruction using bronchial flap and omental flap reinforcement”, Chen *et al.* describe the combination of two minimally invasive approaches: (I) laparoscopic omental flap harvesting and (II) VATS carinal resection and reconstruction in a 32-year-old female patient with an adenoid cystic carcinoma. The omental flap was used to buttress the airway reconstruction for safety reasons since the patient had undergone neoadjuvant therapy before the operation. The authors have to be congratulated on their outstanding surgical performance and the excellent postoperative result of their case. This report comes from a group of surgeons, which is well known for its expertise in minimally invasive surgery. Noteworthy, this dedicated team has recently demonstrated the feasibility of minimally invasive carinal resection/reconstruction and awake anesthesia in a spontaneously breathing patient (12). Although the technical standard reached by Dr. He and colleagues is outstanding, we would like to raise a few words of caution. Despite sporadic reports of successful VATS carinal resection and reconstruction the risk profile of this minimally invasive approach remains unclear as larger case series are lacking. It is debatable if a less invasive combined approach for carinal resection and reconstruction really means more benefit for such a complex group of patients.

Adenoid cystic carcinoma is a rare entity of primary tracheobronchial malignancies (13). They are usually located centrally in the airway. Since submucosal spreading is often evident, the right balance between reaching clear resection margins and a safe reconstruction of the airway is essential. In the reported case the carinal tumor mass was mainly limited to the right main bronchus and only marginally involved the tip of the carina. Thus, a right bronchial sleeve resection with an oblique reinsertion into the carina was possible. Although this is by definition a carinal resection the reconstruction is very different to extended resections in this region of the airway, which either require the creation of a neocarina or an end-to-side

reinsertion of either the left or the right main bronchus.

Omental flaps are an important tool in the armamentarium of thoracic surgery. They are either used to fill infected cavities or buttress bronchial stumps (14,15). Of note the practice of omental flaps has also been propagated in the early days of lung transplantation to reinforce bronchial anastomoses, but the practice has been completely abandoned due to the poor risk/benefit profile. In airway surgery, anastomotic dehiscence is a detrimental complication and associated with high morbidity and mortality. Neoadjuvant chemoradiotherapy was associated with an increased risk of anastomotic failure due to its effect on bronchial blood supply as recently published by Constantino and colleagues (9). However, an association of chemotherapy and bronchial healing problems was not seen in other series of carinal resections (16,17). Local vascularized tissue flaps such as pericardial, pleural or intercostal flaps can also be used to buttress an anastomosis (15). Since the harvesting of omental flaps come with a certain risk for abdominal complications, most centers advocate against a prophylactic omental wrapping. Thus, the necessity of omental flaps has to be critically questioned—in this regard less is definitely more.

Another aspect of carinal surgery, which needs to be addressed here, is the need for ECMO. To our opinion, ECMO can be advantageous in patients harboring complex airway tumors (18). ECMO is superior to cross-field or jet ventilation. A single-site dual lumen VV ECMO should be the cannulation of choice as it facilitates full pulmonary support. However, a central VA ECMO is beneficial for large tumors which require extensive tissue mobilization and long-segment resections, as it also provides hemodynamic support and stability. Excellent results have been reported for complex tracheo-bronchial reconstructions requiring VA ECMO support (19). In experienced ECMO centers the risks associated with cannulation and anticoagulation are negligible.

In conclusion, this report of a VATS carinal reconstruction and omental flap reinforcement underlines the outstanding surgical performance of a well-known team of thoracic surgeons. Innovation requires fearless pioneers who challenge obstacles, which are considered insurmountable. Potential benefits of VATS carinal resections include less surgical trauma and a faster postoperative recovery. However, the risk profile of such an approach remains to be determined. One has to keep in mind that the evidence of VATS carinal resection is still limited to a few case reports. Larger series are needed to

confirm results of this initial experience and to provide guidance for selecting suitable patients for a VATS approach. Only then the question can be answered whether less is really more in patients requiring carinal resections.

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