Carina resection and reconstruction: Our experience and challenges

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SUMMARY

Carina resection is a technically challenging and uncommon procedure in thoracic surgery. This is in part due to the deep and narrow space of dissection to achieve complete resection that is confined by the various major mediastinal vessels, as well as the challenge of maintaining ventilation continuity pre- and post-carina resection. Meanwhile, primary carina neoplasm be it malignant or benign, is uncommon, rendering limited experience even in high-volume thoracic surgery centres. Here, we present a case of an inflammatory myofibroblastic tumour of carina, which has undergone successful carinal resection and reconstruction and discusses some of the operative challenges faced. The patient is currently disease-free and doing well 21 months post-surgery.

INTRODUCTION

Carina resection is a technically challenging and uncommon procedure in thoracic surgery. This is in part due to the deep and narrow space of dissection to achieve complete resection that is confined by the various major mediastinal vessels, as well as the challenge of maintaining ventilation continuity pre- and post-carinal resection. Meanwhile, primary carina neoplasm, be it malignant or benign, is uncommon, rendering limited experience even in high-volume thoracic surgery centres.

Therefore, the important tenets of thorough patient selection, pre-operative evaluation and optimisation, experienced anaesthetist management, sound surgical technique and prompt post-operative management in a multidisciplinary manner are paramount to a positive outcome when embarking on carinal resection.

Here, we present a case of inflammatory myofibroblastic tumour of carina which has undergone successful carinal resection and reconstruction. Discussions mainly focus on the surgical aspects of carinal resection and reconstruction and the challenges faced in our local setting.

CASE REPORT

A 29-year-old woman was referred from a private medical centre for a partially obstructive carina tumour. She presented with chronic cough, wheezing in right lateral position and recurrent episodes of dyspnoea. There was no haemoptysis. In view of the positional-related wheezing, a contrast-enhanced computed tomography (CECT) was performed and showed a lobulated soft tissue lesion at the distal end of trachea arising from the carina, with near total luminal occlusion (Figure 1a). Bronchoscopy revealed a lobulated mass at the lower trachea (Figure 1b), and a biopsy was done. She was referred on the same day to our unit for consideration of surgical intervention.

After multidisciplinary meeting and family counselling, a right video-assisted thoracoscopic surgery (VATS) carinal resection and reconstruction was performed. The airway control was by using a direct intubation of the left main bronchus using a 7-mm single lumen endotracheal tube. Two ports access was used. In the left lateral position, the working port was placed at the fifth intercostal space, 4 cm length just lateral to the anterior axillary line and the second port was placed at the 7th intercostal space, mid axillary line. A 30-degree 10 mm telescope was used.

Dissection was started by mobilising the azygos vein and dividing it with a vascular stapler. The vagus nerve was dissected and anchored to the posterior chest wall. A lobulated and friable carinal tumour extending into the distal tracheal was noted. The trachea, carina, right and left main bronchus were mobilised, looped and divided. Upon division of the left main bronchus, a flexo-metallic tube was inserted through third intercostal space, mid clavicular line to establish cross-field ventilation into the divided left main bronchus. Margins from the proximal trachea, distal right and left main bronchus edges were sent for a frozen section to determine a clear margin before reconstruction (Figure 2a).

The reconstruction was performed by using polydioxanone suture sized 3-0. The lateral wall of the left main bronchus was sutured to the corresponding wall of the trachea. Subsequently, the right main bronchus was sutured to the remnant opening of the left main bronchus-tracheal anastomosis (Figure 2b). In view of the friable membranous portion of the tracheal wall that was tearingduring the suturing, decision was made to convert to thoracotomy to complete the carinal reconstruction. The surrounding pericardial fat was used to cover the anastomosis. There was no air leak seen, and chest drain was inserted prior to closure. She was extubated immediately after surgery.

Chest physiotherapy and incentive spirometry were started early once returned to ward, and nasogastric feeding as well as deep vein thrombosis prophylaxis were commenced on post-op day one. Bronchoscopy assessment was done on post-op day five, and anastomosis was found to be intact, with

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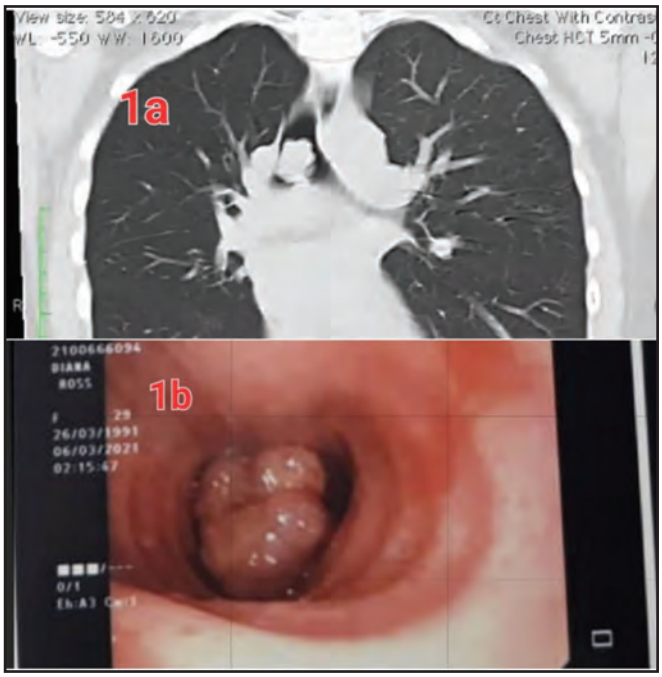

Fig. 1: (a) CECT thorax in coronal view showing the location of the carinal tumour. (b) Pre-operative bronchoscopy showing the carinal tumour.

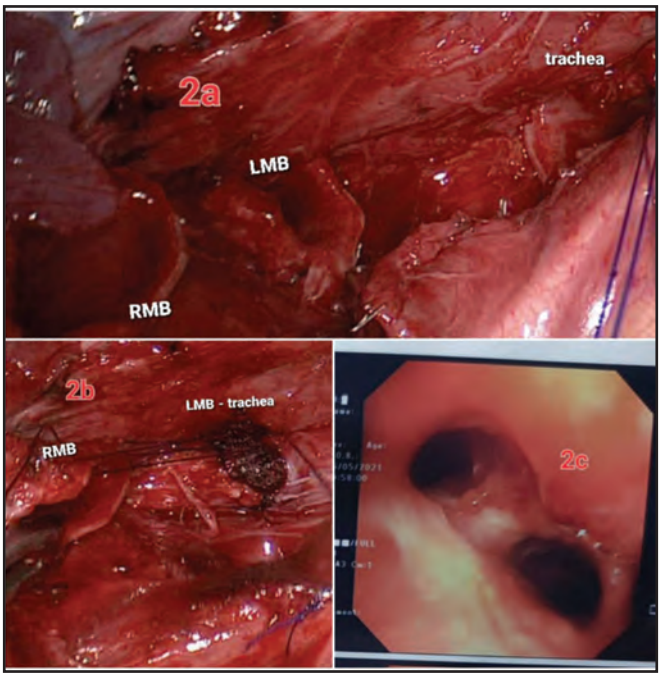

Fig. 2: (a) CECT thorax in coronal view showing the location of the carinal tumour. (b) Pre-operative bronchoscopy showing the carinal tumour.

some mucous plugging seen at the left lower lobe bronchus. Her chest drain was removed, and she was put on soft cervical collar for six weeks. She was discharged home the same day.

Histopathological examination result showed an inflammatory myofibroblastic tumour, and all the lymph nodes were spared. The immunohistochemistry staining was positive for ALK1 and negative for S100, Desmin and PanCK. She was subsequently planned for surveillance by oncology. She was followed up with serial bronchoscopic assessments by us. After a year of surgery, the neocarina looks healthy, with no evidence of recurrence in both the CECT and bronchoscopy (Figure 2c).

DISCUSSION

Benign neoplasm of the carina is rare and can be considered for resection with reconstruction. Although the technicality has been well documented, the complication rate post-op remains high.[1] Detailed preparations with clear communication with anaesthetist and thorough patient selection, pre-operative evaluation and optimisation, sound surgical technique and prompt post-operative management in a multidisciplinary manner are paramount to a positive outcome when embarking on carinal resection.

CECT thorax is the prerequisite that often reveals the presence of a distal trachea/carina lesion. It helps in determining primary tumour extent, mediastinal lymph nodes or lung involvement, and the presence of pleural or pericardial effusion. Magnetic resonance imaging (MRI) is helpful both in delineating the extent of the tracheal tumours into peritracheal tissues and also shows the mediastinal vessel involvement to a better extent, but it is not widely available.

Pre-operative bronchoscopy by the operating surgeon is also very important as it enables a direct visual assessment of the tumour extent, tissue biopsy and potentially therapeutic intervention like debulking to temporarily re-establish airway patency. This is especially important in allowing time for completion of necessary staging, optimisation of patient before surgery and drainage of distal bronchial infection and antimicrobial therapy when warranted. We prefer to perform the bronchoscopy in the operating theatre prior to surgery. This allows a more controlled and safer environment, and airway control could be achieved better if any complications were to arise during the scope. For this patient, there were a few reasons we did not attempt a repeat biopsy or endobronchial intervention. Firstly, the referring pulmonologist found the lesion to be causing significant luminal obstruction and highly vascular, with attempted biopsy resulting in bleeding and airway compromisation. Despite that, the histopathology examination result was inconclusive (spindle cell lesion). More importantly, when pre-operative imaging assessment showed this lesion to be resectable, surgical resection with clear margins was the definitive treatment for this patient who came with a central airway obstruction.

Securing the airway, ventilation and maintaining oxygenation is the ultimate anaesthetic challenge in tracheal or carinal surgery. The double lumen endotracheal tube, a prominent feature in pulmonary surgery, is bulky and not helpful during carinal resection. It hinders tracheobronchial anastomosis compared to smaller lumen catheter like those used in jet ventilation. Cross-field ventilation is often used to help in temporary distal bronchial ventilation.[2] For our patient, a single lumen endobronchial tube was inserted into the left main bronchus directly to achieve single lung ventilation during the initial right video-assisted

thoracoscopic surgery approach. Under bronchoscopy guidance, successful navigation of the tip of the endobronchial tube past the side of the lobulated carinal tumour extension into the left main bronchus was achieved.

The extent of airway resection is determined, on one hand, by the extent of tumour involvement, and limited on the other, by the lack of feasible replacement conduit. A longer extent of airway resection can sometimes be safely compensated by various release manoeuvres to mobilise and advance the resected airway edges in order to achieve a tension-free anastomosis. However, one critical aspect during airway release is that care must be taken to preserve its lateral blood supply. This will prevent devascularisation of the tracheal proximally during pretracheal plane dissection and the bronchial airway distally during peribronchial dissection. Circumferential peribronchial release should be limited to a few millimetres adjacent to the level of transection. The resected carinal length for our patient was about 3 cm.

In this case, a U-shape pericardiotomy around the right inferior pulmonary vein was carried out to provide 1–2 cm of hilar release length to achieve cranial advancement of the right main bronchus. Circumferential pericardiotomy around both pulmonary veins has been described in complete hilar release to achieve greater distal mobilisation. Left hilar release was not performed as tension was not an issue on that side and aortic arch usually prevents significant left main bronchial advancement. Neck flexion also helps descend the larynx and facilitates caudal advancement of the resected distal tracheal edge. This manoeuvre can provide a further 1–2 cm length to help relieve anastomotic tension.[3] For our patient, neck flexion was carried out just prior to anastomosis.

In the case of more extensive involvement of carina resection, different anastomotic configurations have been described in order to achieve additional length and minimise anastomotic tension. One such configuration is an end-to-side anastomosis of the left main bronchus to the cartilaginous wall of the right bronchus intermedius after an initial end-to-end anastomosis of the right main bronchus to the trachea.[4]

Tracheobronchial anastomosis was achieved using synthetic monofilament absorbable (Polydioxanone) sutures. Non-absorbable sutures were found to cause granuloma formation by Grillo et al.[5] Usage of both 3/0 and 4/0 sutures was described in literatures, and we preferred a 3/0 suture for the bigger central airways. Anastomosis was initially performed under video-assisted thoracoscopic approach, where sutures were applied in a continuous manner. During the final stage of anastomosis, the membranous wall of the distal trachea was noted to be flimsy and torn easily due to oedema, which prompted the decision to convert to right anterolateral mini-thoracotomy to gain better traction of both ends of the airway in order to achieve tension free and healthier anastomosis.

Some surgeons advocate wrapping the anastomosis with a pedicled intercostal muscle flap, mediastinal fat, pericardial or pleural flap, while another school of thought practices leaving the anastomosis as it is.[6] It is still debatable if wrapping of the anastomosis helps in reducing the rate of dehiscence and post-op complications such as stenosis, bronchopleural or bronchovascular fistula. In fact, complications like increased thoracotomy pain with intercostal muscle pedicled flap and reossification have been shown with wrapping. There are no strong evidence to date that favour one over another, and we did not place any wrap around our tracheobronchial anastomosis post-carina resection.

Tracheobronchial anastomosis can take up to six weeks to heal. It is crucial to ensure the patient does not extend her neck post-op to keep the anastomosis in a tension-free environment. This can be aided by means of guardian stitches, although some authors found this not mandatory as long as the neck is kept in a neutral position.[7] Grillo stitches were used to maintain the neck in a neutral position after surgery for this patient. The submental crease to presternal skin stitches was removed on fifth day post-surgery after bronchoscopic assessment, and the patient was advised to apply a soft cervical collar to keep the neck in a neutral position without extension for a period of six weeks. Some centres avoid the use of these guardian stitches in compliant patients and reported decreased length of stay.[8]

CONCLUSION

Carina resection and reconstruction is a complex procedure and needs to be undertaken by a team of experienced and skilled thoracic surgeons and anaesthetists. Thorough multidisciplinary discussions and sound perioperative planning hold the key for a successful surgical outcome. Improvements in airway management, intravenous anaesthetic agents and intensive care management have also helped to reduce operative mortality over the past half a century.

DECLARATION

We certify that there is no actual or potential conflict of interest in relation to this article.

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