Feasibility of transtracheal surgical lung biopsy in a canine animal model

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Abstract

Successful natural orifice transluminal endoscopic surgery (NOTES) procedures have been reported in animal studies. However, very little is known about the optimal approach for the application of these surgeries in the thoracic cavity. This study presents the feasibility of transtracheal evaluation of pleural cavity in a canine model using the NOTES technique.

Keywords: Transtracheal approach; Lung biopsy

1. Introduction

Thoracoscopy is the most frequently used method for diagnostic and therapeutic modality for the surgical management of thoracic diseases. Chronic sequelae including chronic pain, numbness and disaesthesia are presented in a total of 31.4% of patients.

The most recently introduced natural orifice transluminal endoscopic surgery (NOTES) has the advantages of requiring no skin incisions and hence no wound discomfort because a natural orifice is used as the entry point [1,2]. Although NOTES has been criticized by some, there is an increasing amount of literature related to NOTES carried out in both human and animal models.

This study presents the feasibility of transtracheal endoloop ligation of lung parenchyma in a canine model using the NOTES technique.

2. Technique

Surgical procedure is performed under general anaesthesia using an endotracheal tube to secure the airway (n = 2). The bronchoscopic procedure consists of the following steps:

(1) A short transverse incision is made on the lateral wall of the lower trachea about 3 cm above the carina using a homemade metal knife under rigid bronchoscopic guidance.

(2) The tracheal incision is sequentially dilated to 9 mm using a homemade metal tube.

(3) A 9-mm trocar is inserted through the tracheal incision and used as an entrance to the thoracic cavity.

(4) A second tracheal incision is made 2 cm above the first tracheal incision proximally and sequentially dilated to accommodate a 5-mm homemade metal tube for manipulation and examination of the thoracic cavity.

(5) The flexible bronchoscope is introduced into the thoracic cavity through the 9-mm trocar for thoracic cavity exploration.

(6) An electrocautery loop is inserted through the working channel of the flexible endoscope to perform a lung resection.

(7) The edge of the resected lung is secured with a homemade endoloop.

(8) The trocar is then removed under bronchoscopic visual control and the patient observed for thoracic vital organ injury.

(9) The tracheal wound is covered with a No. 14 mm stent (Dumon, Novatech, Grasse, France).

(10) The tracheal wound is evaluated with bronchoscopy 2 weeks after surgery.

3. Result

The procedure was entirely carried out in two canines, with an operation time of 100 and 175 min. In one case, the intrathoracic organ was easily evaluated. In the other case, however, the upper lung region was difficult to evaluate through a single tracheal incision, and required further
incision (2 cm above the first tracheal incision) to facilitate exploration. Emphysema and arrhythmia were encountered in one dog and led to intra-operative death. The other animal resumed an oral diet within 24 h after surgery and has not shown subsequent respiratory symptoms or symptoms of airway obstructions.

The elevation of white blood count (WBC) was minimal after surgery. The mean values of WBC before surgery, 3 day and 14 days after surgery were WBC: 15 (5.2—13.9) (1000 µl⁻¹), 18.1 (1000 µl⁻¹) and 14.3 (1000 µl⁻¹), respectively.

On day 14 after surgery, bronchoscopy showed complete healing of the tracheal site after stent removal. The necropsy found in the surviving animal revealed fibrosis at the tracheal puncture site. There was no abscess formation in the paraphrachial region.

4. Discussion

With regard to the endoscopic techniques for managing lung lesion, several modalities have been used for resection of the lesion and prevention of postoperative air leaks after pulmonary resections. The endo-GIA staplers is a safe, effective method for lung resection. However, we did not consider this option in NOTES because the tracheal lumen was not sufficiently wide for introducing the staplers.

Our experience with bullae ablation through video-assisted endoloop ligations demonstrates that the use of a homemade endoloop is feasible in the management of persistent air leaks in patients with spontaneous pneumothorax [3]. Its simplicity has led us to introduce its application in the NOTES experiment.

With regard to entrance (tracheal wound) closure, search for the perfect device to be used for visceral entrance closure after the procedure of NOTES is still ongoing [4]. In our opinion, the optimal devices should be readily incorporated into the lumen of the receiving site and not become a potential focus for infections [5]. The silicone tracheal stent was temporarily used to seal the tracheal entrance without complications.

With regard to intra-operative complication (emphysema and arrhythmia), the use of prophylactic pleural drainage may facilitate the success of NOTES and improve procedure/animal safety. In our opinion, pleural drainage may not be necessary for transtracheal evaluation of pleural cavity and surgical lung biopsy with increasing physician experience.

The difficulty with the transtracheal NOTES is exploration of the upper lung region. This may be achieved using a more proximal tracheal puncture site, 5 cm from the carina (3 cm proximal from the carina was good for hilum exploration). However, trancheal incision should be made with extreme caution to avoid subclavian vessel injury. We hope that further study of optimal tracheal incision site in our lab will facilitate transtracheal NOTES in the applications of thoracic exploration.

With the secure closure of tracheal incision using an airway stent and successful transtracheal NOTES endoloop ligation of lung parenchyma, the current technique seems efficient for intrathoracic exploration. We believe that future technique and material refinements will improve the feasibility of this technique in the management of intrathoracic diseases such as spontaneous pneumothorax (bullae ablation), pericardial effusion (pericardial window creation), mediastinal lesion (biopsy) and lung cancer (staging).

References


Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.ejcts.2009.11.020.