Minimally Invasive Surgical Oncology

www.misurgoncol.com

Minim Invasive Surg Oncol, 2017; 1(1): 31-42. ISSN 2393-3828

Original Article

Anastomosis using complete continuous suture in uniportal video-assisted thoracoscopic bronchial sleeve lobectomy

Zhengcheng Liu, Rusong Yang, Feng Shao

Department of Thoracic Surgery, Nanjing Chest Hospital Affilated to Southeast University School of Medicine, Nanjing, 210029, People's Republic of China

Correspondence to: Yang Rusong, MD, Department of Thoracic Surgery, Nanjing Chest Hospital, Nanjing, Jiangsu Province, 210029, People's Republic of China, Tel: +86-13951677109, Fax: +86-025-83728558, E-mail: njyrs_md@188.com.

Abstract

Objective: To describe complete continuous suture used in bronchial anastomosis in uniportal video-assisted thoracoscopic (VATS) bronchial sleeve lobectomy.

Methods: Seven uniportal VATS bronchial sleeve lobectomy were performed from November 2014 to April 2016 and successfully completed. 3-0 prolene continuous sutures were used to close the bronchial membrane and cartilage. Traction sutures were used to help anastomosis.

Results: The mean surgical time was 201.7 minute, and mean blood loss was 120.0ml. Patient underwent operation successfully. Postoperative bronchoscopy and virtual bronchoscope confirmed no stenosis.

Conclusion: Complete continuous suture was suitable for bronchial anastomosis in uniportal video-assisted thoracoscopic bronchial sleeve lobectomy.

Keywords: uniportal video-assisted thoracoscopic surgery, sleeve lobectomy, continuous suture

Cite this article as: Liu Z, Yang R, Shao F. Anastomosis using complete continuous suture in uniportal video-assisted thoracoscopic bronchial sleeve lobectomy. Minim Invasive Surg Oncol, 2017; 1(1): 31-42.

Introduction

Thoracotomy is the traditional way to perform a bronchial sleeve lobectomy, but it also can be performed by video-assisted thoracic surgery (VATS). The worldwide experience with VATS lobectomy is now suffciently large enough to compare this procedure with open thoracotomy. Multiple interrupted sutures or mixed with continuous sutures

are preferred in bronchial anastomosis, but it can be done using complete continuous suture [1-3]. Most of the complex resections use 2 to 4 incisions, it could also be done using only 1 incision [4, 5]. We report on uniportal VATS bronchial sleeve lobectomy using continuous suture in bronchial anastomosis.

Patients and Methods

Patient Selection

This retrospective study was approved by the institutional review board, and all patients provided written informed consent before operation. Seven uniportal VATS bronchial sleeve lobectomy were attempted from November 2014 to April 2016 and successfully completed, including four cases of right upper lobe (RUL) bronchial sleeve lobectomy, two cases of left upper lobe (LUL) sleeve lobectomy, one case of left lower lobe (LLL) sleeve lobectomy. During that time, 1056 patients were treated surgically for NSCLC, with 827 treated by VATS-approach, 34 sleeve resections underwent thoracotomy, 5 sleeve resections underwent three-port VATS with one conversion to thoracotomy for pulmonary artery bleeding.

Preoperative evaluation included a computed tomographic scan of the chest, cranial magnetic resonance, fiberoptic bronchoscopy, and pulmonary function tests with diffusion capacity. Preoperative clinical tumor stage and other clinical characters were listed in table1. The sleeve resections were planned prior to surgery.

Incision Placement

Surgery was performed under general anesthesia in the lateral decubitus position with single-lung ventilation. Both the surgeon and the assistant who maneuvered the thoracoscope stood anteriorly facing the patient, and a second assistant stood posteriorly. A single incision of approximately 3cm was made in an intercostal space along the anterior axillary line through the fifth intercostal space. Plastic wound protector (Johnson & Johnson, New Brunswick, NJ) was used to stretch open the incision.

Standard minimally invasive instruments for VATS were used. A 10-mm 30-degree thoracoscope (Karl Storz) was inserted. The thoracoscope and several thoracoscopic instruments were simultaneously fitted into the uniport. No additional skin incisions or counter-incisions were made for any purpose such as placement of thoracoscope, graspers, or drains. Ribs were not spread, resected, or fractured during the operation, and there was strict avoidance of metallic retraction. It is very important to keep the camera in the posterior part of the incision, a gauze sling around the thoracoscope was used to maintain the position. Other instrument should be operated below the camera (**Figure 1**).

Operative Technique

RUL sleeve lobectomy

Staple was perfered for pulmonary arterial branches ligation. After division of the vessels and opening the fissure, the bronchial sleeve resection may begin. The bronchus intermedius and right mainstem bronchi were circumferentially dissected 1.0cm away from right upper bronchi using a long scalpel and scissors, then mobilization of right upper lobe, with care not to devascularize the airway. Fast frozen

pathology confirmed no residual tumor.

Dividing the inferior pulmonary ligament was performed to release the tension of airway. Then end-to-end anastomosis begun by placing traction sutures at posterior cartilaginous-membranous junction using 3-0 prolene(Ethicon, Somerville, NJ), knot was tied outside with a thoracoscopic knot pusher. Continuous sutures were used to close the bronchial membrane (from posterior to anterior) and cartilage (from posterior to anterior). Care was taken not to get sutures twisted (**Figure 2**).

Traction sutures were helpful for anastomosis. Sutures were applied at both bronchus intermedius and right mainstem bronchi and tracted outside incision. When pulled up, the posterior bronchus margines would get closer and have a longer distance from vessels, making anastomosis of posterior wall much easier. When anastomosis of posterior wall was completed, traction sutures were cut and removed in order to avoid tangling with other sutures. We designed a novel long seperating forcep with a greater arc to retract the vessels or push vessles away from bronchus, also benefitting bronchial anastomosis.

Anastomosis air leak was tested by dragging tight sutures and submerging bronchus under saline and inflating the lung with a pressure of 20 cm of water. Then the sutures were finally knotted at anterior cartilaginous-membranous junction with confirmation of no air leak existance without using any tissue flap (**Figure 3**).

LUL sleeve lobectomy

The main bronchus and lower lobe bronchus proximal and distal to the base of the LUL were incised. A running suture is started at the anterior cartilaginous-membranous junction, after tying knot, posterior wall anastomosis was completed first and another running suture is used to complete the anterior half of the anastomosis. Final knot was tied at posterior cartilaginous-membranous junction.

LLL sleeve lobectomy

The left lower sleeve lobectomy is technically more complex for the presence of the pulmonary artery and upper lobe vein. Left main bronchus was dissected first, and then the upper lobe bronchi was cut circumferentially. The first suture was palced at anterior cartilaginous-membranous junction to help appose the upper lobe bronchi and mainstem bronchi, and then proceeded with a continuous suture in the posterior wall of airway (the most difficult part of anastomosis). Another running anterior suture was performed and both sutures are tied with the help of a thoracoscopic knot-pusher.

Systematic lymph nodes desection was permformed in all patients. A single chest tube through the incision was placed.

Result

Seven patients (five males and two females) with a median age of 61.4 years (range: 48-73 years) underwent uniportal VATS bronchial sleeve lobectomy. The mean surgical time was 201.7±18.9 minutes (range: 166-258). Mean blood loss was 120.0±65.3ml (range: 50-250). Pathological examination showed squamous cell carcinoma (SCC) in all patients, N1

Figure 1 A single incision of approximately 3cm was made

lymph nodes were positive in two patients, negative in four patients. N2 lymph nodes were all negative (Table 2).

Five patients extubated after surgery, two patients were mechanically ventilated after the surgery for 1.0 and 1.5 hours respectively for high partial pressure of carbon dioxide in blood gas and successfully extubated. No patient required continuous positive airway pressure or suffered acute life-threatening events. Mucous impaction at anastomosis site was developed in two patients and treated successfully by sputum suctioning with bronchoscopy.

All patients survived and were discharged with median total length of stay of 12.6± days (range: 9-17), and discharged post-surgery of 7.5±2.6 days (range: 5-13). Mean chest tube duration was 5.5±1.8 days (range: 4-11) without chest tube re-insertions. The patients recovered without complications (bronchial stenosis, fistula) or other notable events, signs of tumor recurrence or metastasis during follow-up time. Postoperative bronchoscopy and virtual bronchoscope confirmed no stenosis. Pulmonary function tests were performed six months after the surgery, the mean FEV1/FVC was 70.5±12.6% (range: 55.1-95.2%), and the mean MVV was 77.4±18.8 L/min (range: 49.5-88.9 L/min).

Discussion

Since the first VATS lobectomy performed in the early 1990s, many authors worldwide have published reports confirming its safety and advantages, including smaller incisions, decreased postoperative pain, shorter length of stay, decreased chest tube output and duration, decreased blood loss, better preservation of pulmonary function, and earlier return to normal activities. VATS lobectomy may even offer reduced rates of complications and better survival without sacrificing the oncologic principles [6-10].

The first reports of VATS sleeve resection only appeared 15 years ago. There are few reports of VATS sleeve resection performed with no direct visualization and no rib retractor (11-13). Most of the authors describe the VATS approach to lobectomy with 3 to 4 incisions, but the surgery can be performed by only 1 incision with similar outcomes [14-16]. Since 2013, we have used the uniportal approach for VATS lobectomy and performed more than two hundred uniportal VATS lobectomy till now. More complex cases could be performed with uniportal VATS including bronchial sleeve lobectomy as

Table 1 Clinical characteristic of patients

Patient number	Age(years)	Sex	Smoking history	FEV1 (L)	FEV1/FVC (%)	Body mass index	ASA score	Clinical TNM stage
1	59	Male	yes	2.01	75.3	22.1	1	cT2aN0M0
2	67	Male	Yes	1.77	68.2	24.5	1	cT2aN0M0
3	48	Female	Yes	1.85	82.6	23.6	1	cT1b N1M0
4	64	Male	Yes	2.34	78.5	25.0	1	cT2aN1M0
5	68	Male	Yes	1.69	59.7	28.7	1	cT1bN1M0
6	73	Male	Yes	1.98	66.5	23.3	1	cT2aN1M0
7	51	male	Yes	2.71	97.5	21.9	1	cT2aN1M0

FEV1: forced expiratory volume in one second
FVC: forced vital capacity
ASA: American Society of Anesthesiologists

Table 2 Postoperative data of patients who underwent uniportal video-assisted thoracoscopic surgery sleeve lobectomy

Patient number	Tumor diameter (cm)	Histology	Tumor location	Operation duration (min)	Blood loss (ml)	Postoperative stay (days)	FEV1(L)	FEV1/FVC (%)
1	2.0	SCC	RUL	189	150	13	1.89	73.4
2	1.6	SCC	RUL	175	90	8	1.72	62.8
3	2.2	SCC	LUL	211	250	7	1.48	73.5
4	3.5	SCC	LUL	258	120	8	1.96	70.6
5	1.2	SCC	RUL	166	50	6	1.15	56.7
6	1.9	SCC	LLL	232	100	6	1.75	61.5
7	2.5	SCC	RUL	181	80	5	2.65	95.2

SCC: squamous cell carcinoma, RUL: right upper lobe, LUL: left upper lobe, LLL: left lower lobe, FEV1: forced expiratory volume in one second, FVC: forced vital capacity

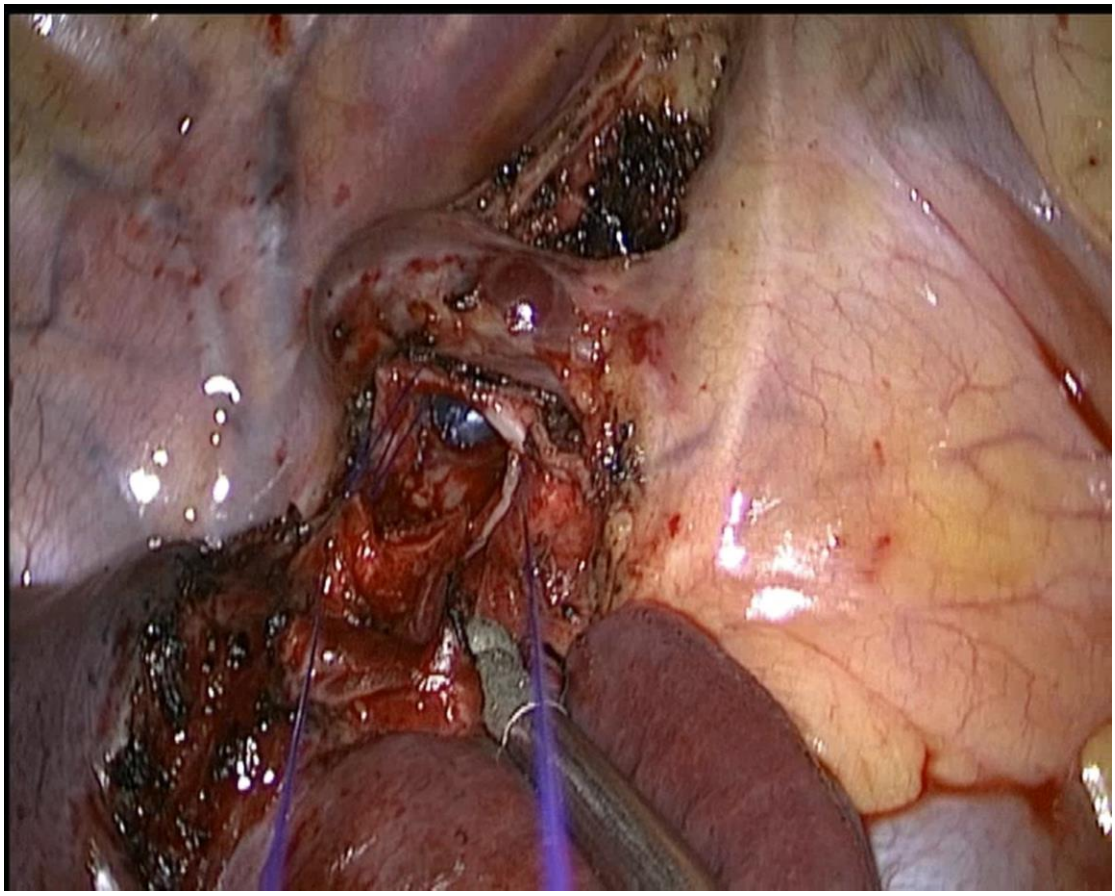

Figure 2 Continuous sutures was used to close the bronchial membrane and cartilage

experience accumulated.

Traction sutures were greatly helpful for anastomosis [17]. The bronchus were divided at a right angle to its long axis and between cartilages [18]. Anastomosis of posterior bronchus would be much easier because margines were closer and away from surrounding tissue. Gonzalez-Rivas has reported the first case of bronchial sleeve lobectomy by uniportal VATS, however, bronchial anastomosis was completed by continuous membranous suture with a posterior stitch in the cartilaginous-membranous junction and interrupted sutures for the anterior cartilaginous portion [19-24]. In our experience, it was hard to avoid tangling the ends of the untied ends during interrupted sutures. In contrast, holding traction sutures at the direction of anastomosis, sutures would be completed much easier with clear visualiztion. More clinical trail should be applied to compare continuous sutures and other way to complete bronchial anastomosis.

Most of reports describe the VATS approach using interrupted sutures in anastomosis, or combine interrupted with continuous sutures, especially in bronchus cartilage reconstruction [25-31]. The end-to-end anastomosis could also be performed by complete continuous suture, either through VATS or uniportal VATS [32-36]. Continuous suture was used to complete both membranous bronchus and cartilage anastomosis at one time through thoractomy in our institute since 2003

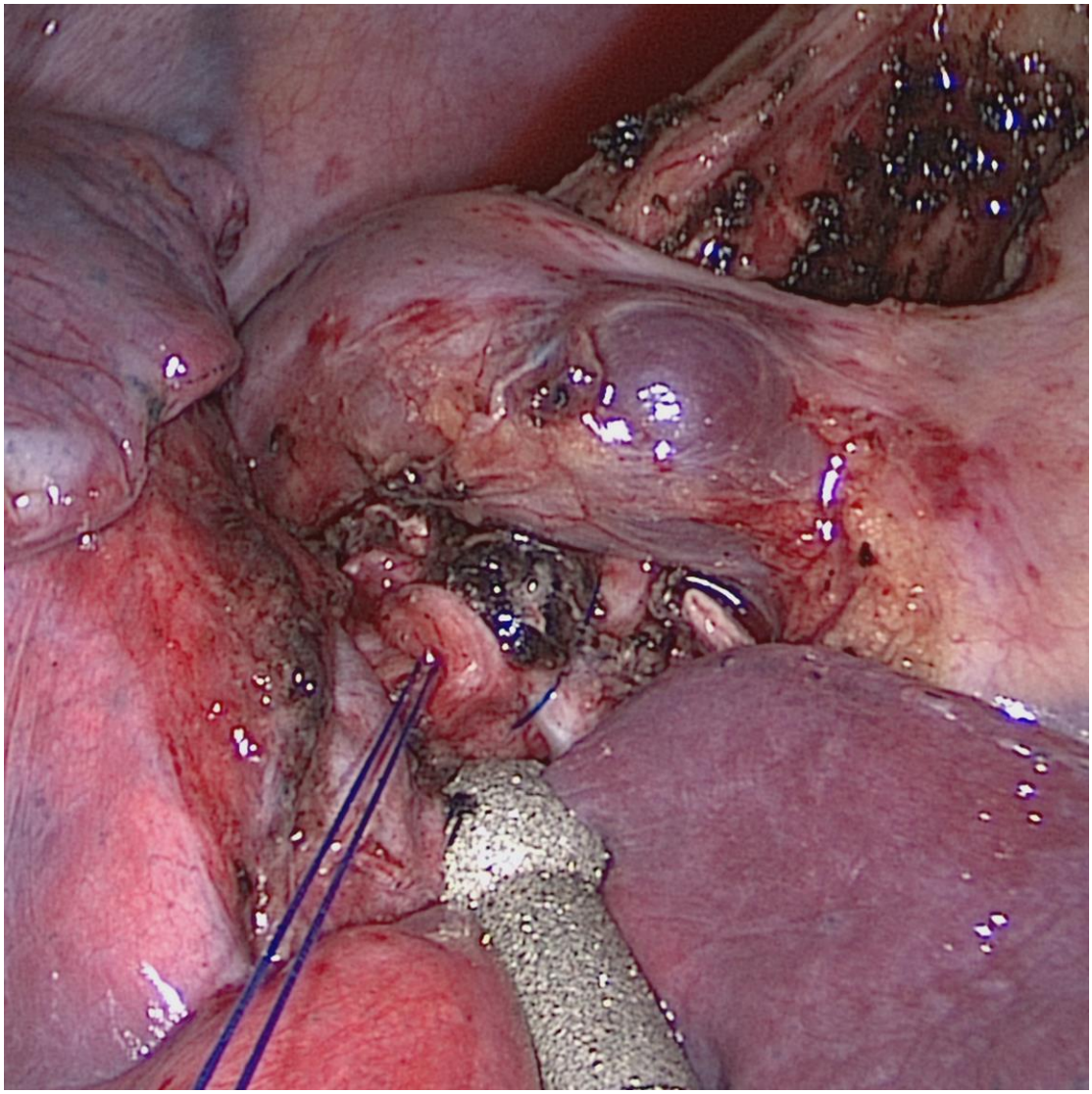

Figure 3 The sutures were knotted at one time with confirmation of no air leak existence

and applied with three-port VATS since 2013. Now we were able to perform sleeve lobectomy with uniportal VATS. Usually, the first step is to suture the posterior bronchus wall and then the second step is to suture the anterior bronchus wall, both edges were tied at the front. In follow-up time, no sign of stenosis was observed. Continuous suture facilitates both smooth stitch placement and sliding of the knots, leading to low incidence of stenosis.

We dragged tight and knot sutures after anastomosis air leak was tested, which could enable additional sutures when small air leak was found. Continous sutures was also an ideal way to avoid tangling the ends of the untied ends [37]. It was quite clear to adjust sutures for any size discrepancy between the proximal and distal airways with precise suture placement along the circumference of the anastomosis. Besides, tension could be carefully and easily adjusted with a sliding knot-pushing instrument.

There were also disadvantages of continuous sutures [38-40]. Once tangling or intersects happened, suture should run backward to have these

problems overcome to continue suture. It was also technically hard to complete continuous suture with only one port. The angle of needle insertion were different at every suture, the position of needle holder were changing accordingly, calling for great care.

The left lower or upper sleeve lobectomy is more complex than RUL because of the interference with aortic arch and main PA and the short length of upper lobe bronchus, the absence of intermediate bronchus [41]. Subcarinal lymph node dissection should be performed before the bronchial division, facilatates bronchus anastomosis [42]. The continuous suture technique should be performed in two steps, bronchial membrane at first from anterior to posterior and then cartilage from anterior to posterior, every 180 degree of the bronchus circumference [43].

Complete continuous suture used for bronchial anastomosis in uniportal video-assisted thoracoscopic bronchial sleeve lobectomy was described, however, small sample size and short follow-up time was the main limitation of this study, more cases should be reviewed with longer follow-up time for further research.

Conclusion

As experience has grown, the list of contraindications to VATS has shrunk. Uniportal VATS would become more popular with acceptable morbidity and mortality as well as fast recovery.

Conflict of interest

The authors have no potential conflicts of interest to disclose

Acknowledgements

We sincerely thank our hospital colleagues who participated in this research.

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