



An antiquated contraindication for minimally invasive lung surgery: No place to staple the bronchus

Minimal invaziv akciğer kanserinde eski bir kontrendikasyon: Bronşiyal staplere yer yok

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ABSTRACT

Background: This study aims to evaluate the feasibility and outcomes of lobectomy operations without using a stapler for bronchial closure.

Methods: Between December 2014 and August 2018, a total of 108 patients (72 males, 36 females; mean age 62.1±9.8 years; range, 19 to 83 years) with primary lung cancer who underwent lobar resection with robot-assisted thoracoscopic surgery were included in this study. Primary bronchial closure (n=7) and sleeve anastomosis (n=9) were performed in some cases. These 16 patients were compared with other lobectomy cases (n=92) who had bronchial stapling for bronchial closure.

Results: There was no statistically significant difference in the mean duration of operation, amount of intraoperative bleeding, length of postoperative stay in the hospital, and morbidity and readmission rates between the two groups (p=0.3, p=0.5, p=0.06, p=0.4, and p=0.63, respectively). No bronchial fistula developed in any of the patients.

Conclusion: Primary bronchial closure and sleeve anastomosis can be safely performed with robot-assisted thoracoscopic surgery without conversion to thoracotomy, or a larger assistance incision with a similar success rate of the stapled bronchus.

Keywords: Primary bronchial closure, robot-assisted thoracoscopic surgery, sleeve anastomosis.

ÖZ

Amaç: Bu çalışmada bronşiyal kapatmada stapler kullanmaksızın lobektomi ameliyatlarının yapılabilirliği ve sonuçları değerlendirildi.

Çalışma planı: Bu çalışmaya Aralık 2014-Ağustos 2018 tarihleri arasında robot yardımcı torakoskopik cerrahi ile lobar rezeksiyon yapılan primer akciğer kanserli toplam 108 hasta (72 erkek, 36 kadın; ort. yaş 62.1±9.8 yıl; dağılım, 19-83 yıl) alındı. Bazı hastalara primer bronşiyal kapatma (n=7) ve sleeve anastomoz yapıldı. Bu 16 hasta, bronşiyal stapler ile bronşiyal kapatma yapılan diğer lobektomi olguları (n=92) ile karşılaştırıldı.

Bulgular: İki grup arasında ortalama ameliyat süresi, ameliyat sırasında kanama miktarı, ameliyat sonrası dönemde hastanede yatış süresi ve morbitite ve tekrar yatış oranları açısından istatistiksel olarak anlamlı bir fark yoktu (sırasıyla, p=0.3, p=0.5, p=0.06, p=0.4 ve p=0.63). Hastaların hiçbirinde bronşiyal fistül gelişmedi.

Sonuç: Primer bronşiyal kapama ve sleeve anastomoz, torakotomiye dönmeden veya yardımcı insizyonu büyütme gerek duymadan robot yardımcı torakoskopik cerrahi ile güvenle ve stapler ile kapatılan bronş ile benzer başarı oranları ile yapılabilir.

Anahtar sözcükler: Primer bronşiyal kapama, robot yardımcı torakoskopik cerrahi, sleeve anastomoz.

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Minimally invasive thoracic surgery, namely video-assisted thoracoscopic surgery (VATS), has become a preferred method for the resection of early-stage lung cancer based on the studies showing its superiority with shorter postoperative hospital stay, less tissue injury, improved cosmetic results, and lower morbidity.^[1,2] For central lung cancer, particularly when the lobar bronchial orifice is invaded by the tumor or an N1 lymph node, minimally invasive surgery is still challenging, although experts of VATS can present excluded cases with superior techniques requiring combined procedures.^[2] Tumors with a central location can be still considered for conversion to an open surgery or an absolute contraindication in traditional minimally invasive surgery.^[3] There are reports showing that sleeve lobectomy by thoracoscopy may be feasible in experienced centers by experienced surgeons.^[3] However, it is still not a widely accepted procedure due to technical difficulties.

Primary bronchial closure and bronchial sleeve anastomosis are still more complex procedures, compared to a standard lobectomy with minimally invasive techniques using a bronchial stapler in the perspectives of the most recent technology.^[4,5]

Robot-assisted thoracoscopic surgery (RATS) has alleged superiorities to VATS for such complex procedures, owing to improved flexibility of the EndoWrist® (Intuitive Surgical, Inc. Sunnyvale, California, USA) instruments, more intuitive movements, and high-definition three-dimensional vision.^[6]

In the present study, we aimed to evaluate RATS lobectomies in which a bronchial stapler was used to close the bronchus and compared these results with those obtained after primary bronchial closure with sutures and bronchial sleeve resections and anastomosis.

PATIENTS AND METHODS

December 2011 and August 2018, more than 350 patients underwent RATS in our clinic. In recent years, RATS lobectomy has become a routine technique in our clinic, and a bronchial stapler (Ethicon/Johnson & Johnson, Cincinnati, USA; or Medtronic, Dublin, Ireland) is almost always used for bronchial closure during anatomic lung resections. When the primary tumor or an N1 lymph node invades the lobar bronchus, bronchial management is performed either by cutting the bronchus without stapling and primary suture closure or by bronchial sleeve resection and anastomosis. In 2011, a RATS lobectomy and primary

bronchial closure with RATS was done in only one patient, who was the first robotic case in our clinic. However, we excluded this initial patient and decided to analyze our patients from December 2014 to August 2018, when we did the second case. Segmentectomy and pneumonectomy cases were also excluded due to statistical analysis difficulties. Finally, a total of 108 patients (72 males, 36 females; mean age 62.1±9.8 years; range, 19 to 83 years) with primary lung cancer who underwent lobar resection with RATS were included in this study. A written informed consent was obtained from each patient. The study protocol was approved by the Süreyyapaşa Training and Research Hospital Ethics Committee (No: 116.2017.093). The study was conducted in accordance with the principles of the Declaration of Helsinki. Primary bronchial closure (n=7) and sleeve anastomosis (n=9) were performed in some cases. These 16 patients were compared with other lobectomy cases (n=92) who had bronchial stapling for bronchial closure. Data including age, gender, surgical techniques, surgical materials used during the bronchial closure, amount of intraoperative bleeding, duration of operation, and length of postoperative stay in the hospital, readmission rate, morbidity, and postoperative complications were compared between the two groups.

Surgical technique

General anesthesia was performed in the supine position, and a left double-lumen endobronchial tube was placed routinely. We routinely controlled the position of the endotracheal tube by fiberoptic bronchoscopy after positioning the patient to lateral decubitus. After inserting the ports, the robot was docked. We often performed the approach using the three-arm (sometimes four-arm) VATS-based technique described elsewhere.^[6,7] The anterior arm was inserted through a 3 to 4-cm utility incision. Staplers are routinely used for lobar bronchus closure during all lobectomy operations. Cutting the bronchus without stapling, and primary suture closure or bronchial sleeve resection and anastomosis were performed, if tumors or invasive lymph nodes invaded the proximal bronchi or lobar orifices. In our first four cases, we used 3-0, and 4-0 prolene sutures for closures and anastomosis. The V-loc (barbed sutures; Medtronic, Covidien New Haven, CT, USA) was preferred in the final 13 patients either for primary closure or anastomosis.

Statistical analysis

Statistical analysis was performed using the IBM SPSS version 21.0 software (IBM Corp.,

Table 1. Demographic and clinical characteristics of patients

	Without Stapler (n=16)			With Stapler (n=92)			<i>p</i>
	n	%	Mean±SD	n	%	Mean±SD	
Age (year)			59.4±14.8			62.6±8.6	0.66
Gender							0.56
Female	5	35.3		30	32.6		
Male	11	64.7		62	67.4		
Resection							
Bilobectomy	0			3			
Lobectomy							
Upper	10			59			
Middle	0			6			
Lower	6			24			
Side							
Right	11			50			
Left	5			42			

SD: Standard deviation; *p*-value was calculated with chi-square test.

Armonk, NY, USA). Descriptive data were expressed in mean and standard deviation (SD), median (min-max) or number and frequency. Categorical variables were compared using the chi-square tests. The Mann-Whitney U test was used to compare continuous variables. A *p* value of <0.05 was considered statistically significant.

RESULTS

Of all patients, 16 underwent bronchial management including primary closure in seven patients or bronchial sleeve anastomosis in nine patients. In 92 cases, a bronchial stapler was used for lobar bronchial closure during lobectomy. There was no significant difference in the demographic characteristics of the patients. A detailed summary of patient characteristics is provided in Table 1.

The mean operation time in the bronchial stapler group was 148.7±5 (range, 75 to 300) min vs. 160±12.8

(range, 80 to 240) min in the without a bronchial stapler group (*p*=0.3). The mean amount of intraoperative bleeding and length of hospital stay were also comparable between the two groups (63.1±23.6 mL vs. 63.8±40.5 mL, respectively; *p*=0.53 and 8.15±2.8 days vs. 7.17±2.9 days, respectively; *p*=0.06) (Table 2, Figure 1).

Of 16 patients who underwent primary bronchial closure or sleeve resection, primary suture closure of the bronchus was performed in seven patients (n=3 right upper lobectomy, n=2 right lower lobectomy, n=1 left upper lobectomy, and n=1 left lower lobectomy). Bronchial sleeve resection and anastomosis were performed in nine patients (n=5 right upper sleeve lobectomy, n=1 right lower sleeve lobectomy, n=2 left lower sleeve lobectomy, and n=1 left upper sleeve lobectomy). Also, isolated bronchial sleeve resection and anastomosis were performed in one patient. Polypropylene (Prolene®) was used in the first

Table 2. Intra- and postoperative data

	Without bronchial stapler	With bronchial stapler	<i>p</i>
	Mean±SD	Mean±SD	
Operation time (min)	160±12.8	148±5	0.3
Operation drainage (mL)	63.1±23.65	63.8±40.5	0.53
Hospitalization (day)	8.15 ±2.8	7.17± 2.9	0.06

SD: Standard deviation; The *p*-values correspond to a comparison between each group with the Mann-Whitney U test.

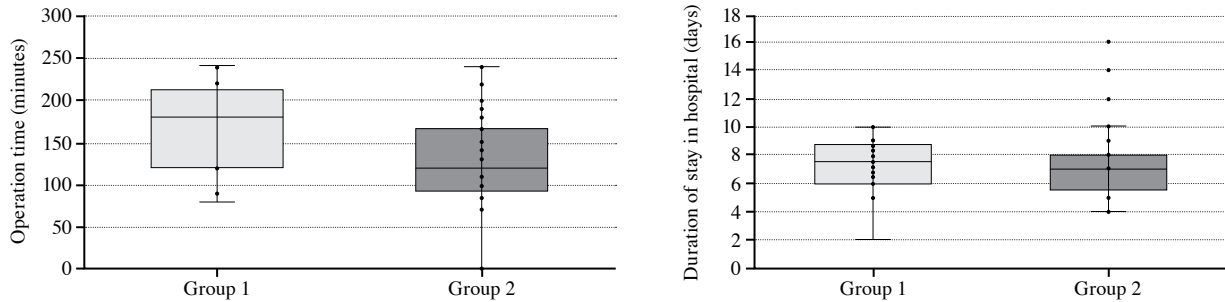


Figure 1. Length of hospital stay and operation times of patient groups.

four cases, while V-loc (barbed sutures; Medtronic, Covidien, New Haven, CT, USA) suture was preferred in the final 10 cases.

The patients in the bronchial management group experienced the following complications: four patients had pneumonia, and two patients developed atrial fibrillation. In the stapler group, eight patients had prolonged air leaks, two patients had pneumonia, one patient had a gastrointestinal complication, one patient had myocardial ischemia, one patient had acute respiratory distress syndrome, five patients had atrial fibrillation, and one patient had pneumothorax ($p=0.45$).

The readmission rate was 18.7% in the without stapler group and 14.3% in the stapler group. Three patients were readmitted due to pneumonia in the without stapler group. In the stapler group, 13 patients were readmitted due to prolonged air leaks in two, pneumonia in five, hemoptysis in one, neuralgia in two, dyspnea in one, empyema in one, and atrial fibrillation in one. There was no significant difference between the two groups ($p=0.633$).

DISCUSSION

Complete surgical resection is the most optimal treatment for Stage I and II non-small cell lung cancer patients.^[8] It is well-known that positive margins of the bronchial stump are associated with both higher recurrence rates and worse survival rates.^[9] Tumors invading the lobar bronchus or close to the proximal lobar bronchi may be a potential problem in the complete resection of the lung with minimally invasive techniques. Compared to stapling, cutting the bronchus without stapling and primary suture closure may provide a wider surgical margin and potentially may keep the suture line away from the invasive tumor.^[6]

The incidence of bronchial and arterial sleeve resections to treat lung cancer patients with centrally located tumors or with other indications has increased

over the years to avoid fatal complications of pneumonectomy.^[10] Indications for sleeve resections include a centrally located distinct malignancy, intraluminal tumor infiltrations of peribronchial or extrabronchial areas, and invasive involvement of lymph nodes (NI) of these areas.^[11] Suitably located endobronchial carcinoid tumors or benign lesions such as endobronchial hamartomas can be defined as other indications for bronchial sleeve resections.^[6]

Minimally invasive surgery has become the surgical technique of choice to perform with almost all thoracic operations in the last two decades. In particular, VATS is used by practically every thoracic surgery department as a standard method. More recently, RATS has become the focus of debate due to alleged superiorities such as improved flexibility of the EndoWrist® instruments, more natural movements, and high-definition three-dimensional vision. We believe that RATS can be defined as a development of a next-generation minimally invasive thoracic surgery.^[6]

In the last decade, bronchial and pulmonary vascular sleeve resections and anastomosis were thought to be the first absolute and, then, a relative contraindication in VATS. However, thanks to technological advances and the experience gained by high-volume centers, these procedures have become feasible by VATS.^[12] Owing to technical superiorities of RATS, sleeve resections can be performed safely with both early and late satisfactory outcomes.^[13] We believe that performing sleeve resections with VATS may need a high-volume center and experienced thoracic surgeons or these two parameters may be prerequisites. However, in RATS, this would not be expected to be the case.

In our clinic, we performed the first primary bronchial closure in December 2011 using robotic surgery. We preferred to include these patients who were operated after December 2014, as our experience in bronchial management increased. Throughout the

study period, 16 patients of 125 lobectomies underwent bronchial management.

In a study, Casiraghi *et al.*^[14] reported that the median operation time was 192 min for lobectomy, 172 min for segmentectomy, and 275 min for pneumonectomy in their 10-year experience with robotic surgery. Another study reported their results for the mean duration of surgery as 185.63 min.^[15] Consistent with the literature, in our study, the mean operation times were 160±12.8 min in patients in the without a stapler and 148±5 min in the stapler group, indicating comparable operation time between the two groups.

In the study by Casiraghi *et al.*,^[14] the median length of stay in the hospital was five (range, 2 to 191) days. However, this duration was higher in our study (8.15±2.8 days for the without stapler group and 7.17±2.9 for the stapler group). Even standard lobectomy patients had longer hospital stays in our study. This difference may be due to our populations' demand to remain in the hospital, until the chest drain is removed. In Turkey, although we encourage patients to discharge, the rate of patients discharged with a Heimlich tube is lower, compared to those in the North America.^[16] On the other hand, the amount of intraoperative bleeding, the rate of readmission, morbidity, and complications were comparable between the two groups.

In general, the stapler is preferred for the bronchus. In our study, we performed primary closure or sleeve anastomosis only if tumors were present, or lymph nodes were involved, or it was close to the proximal bronchi or lobar orifice. Therefore, patient groups were not similar in terms of pathological stage and localization of tumors. Sleeve patients or primary closure patients had higher T and N stages, and we were unable to evaluate long-term outcomes comparisons are not possible, as most bronchial without stapler patients had adjuvant chemotherapy. This can be deemed as the main limitation of our study.

In conclusion, our study results suggest that when bronchial primary suture closure or sleeve resection is required during surgery for lung cancer, the procedure can be safely performed with robot-assisted thoracoscopic surgery, and conversion to thoracotomy may not be necessary.

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