Research Square

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Technical Considerations for Reducing The Cost of Robotic Lobectomy for Lung Cancer

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Research Article

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Abstract

Background

The cost of robotic assisted surgery is an obstacle to wider implementation. We aimed to evaluate the effect of our strategy to reduce the cost of robotic lobectomy (RL) for lung cancer.

Methods

This single institutional retrospective study included RL for lung cancer between October 2018 to November 2019. We initiated minimal RL (miRL) in September 2019 aiming to reduce the consumable cost, in which we intended to use only bipolar fenestrated (left), long bipolar grasper (right) and vessel sealer (3rd arm) as robotic instrument. Additional consumable cost was calculated based on Japanese catalog price (1USD = 110JPY) to perform RL (excluding robot and maintenance fee, and staplers) compared to our video assisted thoracoscopic surgery lobectomy (VATS-L) (3 ports, no energy device). We then assessed the effect of miRL on the cost and perioperative outcomes.

Results

Twenty-one RATS-L were performed [20 c-stage I and one c-T3(PM1)N0M0]. There were no significant differences in patient characteristics between the miRL group (N = 6) [age 73(56–76); male 67%; tumor size 18(5–33) mm] and the Control group (N = 15) [age 68(50–84); male 60%; tumor size 13(8–32) mm]. In all cases with miRL, procedure was completed with only 3 arms. The mean (range) additional consumable cost to perform RL compared to VATS-L was significantly reduced in the miRL group compared to the control group [Control 2168(1808–2746) vs miRL 1424(1424–1424) USD, $p < 0.01$]. There was no conversion to thoracotomy or grade > 4 complications. There were no significant differences in blood loss [Control 25(0-203) vs miRL 30(0-152) g, p = 0.90], operation duration [Control 193(106–284) vs miRL 179(154–211) mins, p = 0.53] or postoperative hospital stay [Control 4(3–10) vs miRL 4(3–17) days, p = 0.87].

Conclusions

With miRL strategy in our cohort, consumable cost for RATS-L was significantly reduced while maintaining perioperative outcomes. Further evaluation with larger number of patients is warranted.

Introduction:

The cost of robotic surgery is an obstacle to wider implementation. We evaluated the cost-effectiveness of our institutional strategy to reduce the consumable cost of robotic lobectomy (RL) for early-stage lung cancers.

Methods:

This study was approved by the institutional review board (Ashikaga: No 2019-43) on February 5, 2020 and consent was waived. This single institutional retrospective study included consecutive cases of RL for lung cancer completed between October 2018 and November 2019 (Ashikaga). All procedures, including a systematic lymph node dissection, were performed by a single operator (KH) with da Vinci Xi surgical system (Intuitive Surgical, Sunnyvale, CA, USA), using all 4 arms. To reduce consumable cost, we initiated a minimal RL (miRL) strategy in September 2019 attempting to use only three robotic instruments (other than robotic staplers): bipolar fenestrated (left arm), long bipolar grasper (right arm), and vessel sealer (third arm) unless otherwise required (Fig. 1, **Online Resource 1**). Before this strategy was implemented, we used any robotic instruments necessary to mimic our existing video-assisted thoracoscopic lobectomy (VATS-L) technique. We also omitted carbon dioxide insufflation (AIRSEAL was otherwise used) in this strategy. Additional consumable cost was calculated based on a Japanese catalog price (1 USD = 110 JPY) for performing RL (excluding robot itself, its maintenance fee, and staplers), in addition to our VATS-L (3 ports, no energy device) instrument set. We then assessed the cost and perioperative outcomes of miRL.

A comparison was performed using the non-parametric t-test for continuous values, and the Fisher's exact test for categorical values. All p-values were two-sided, and < 0.05 were considered statistically significant.

Results:

Twenty-one RL were performed. There were no cases with concomitant vascular/bronchial reconstruction procedures. There were no significant differences in patient characteristics between the miRL group (N = 6) and the control group (N = 15) (Table 1: Characteristics). There were no cases with concomitant resection of the surrounding structures or vascular/bronchial reconstruction procedures.

Table 1
Characteristics and outcomes of robotic lobectomy for lung cancers

	Control Group (N = 15)	**miRL group (N = 6)**	**p value**
Characteristics			
Age	68 (50–84)	73 (56–76)	0.99
Male	9 (60%)	4 (67%)	0.99
Tumor size (mm)	13 (8–32)	18 (5–33)	0.72
BMI	23 (19–27)	23 (18–25)	0.39
% FEV1L	113 (59–162)	119 (101–142)	0.53
Smoking (pack-year)	5 (0-174)	17 (0–33)	0.99
c-stage			0.99
IA/B	12/2 (93%)	5/1 (100%)	
IIA/B	0/1* (7%)	0/0 (0%)	
Resected lobe			0.61
Right upper	4 (27%)	1 (17%)	
Right middle	1 (6%)	2 (33%)	
Right lower	2 (13%)	1 (17%)	
Left upper	4 (27%)	1 (17%)	
Left lower	4 (27%)	1 (17%)	
Outcomes			
Number of robotic instruments**	6 (4–8)	3 (3–3)	< 0.01
Use of CO_2 insufflation	11 (73%)	0 (0%)	< 0.01
Consumable cost (USD)***	2168 (1808–2746)	1424 (1424–1424)	< 0.01

Median (range)

*cT3(PM1)N0M0

** Excluding robotic camera and staplers.

***Additional consumable cost to perform RL compared to VATS-L.

miRL, minimal robotic lobectomy; *BMI*, body mass index; *FEV*, forced expiratory volume.

	Control Group (N = 15)	miRL group (N = 6)	p value
Conversion to thoracotomy	0 (0%)	0 (0%)	0.99
Complication rate (≥ grade 3)	1 (7%)	0 (0%)	0.99
Intraoperative blood loss (g)	25 (0-203)	30 (0-152)	0.90
Operation duration (min)	193 (106–284)	179 (154–211)	0.53
Chest tube duration (days)	2 (1–8)	1.5 (1–13)	0.49
Postoperative stays (days)	4 (3–10)	4 (3–17)	0.87
Median (range)			
*cT3(PM1)N0M0			
** Excluding robotic camera and staplers.			
***Additional consumable cost to perform RL compared to VATS-L.			
miRL, minimal robotic lobectomy; *BMI*, body mass index; *FEV*, forced expiratory volume.			

The intraoperative and short-term outcomes are summarized in Table 1: Outcomes. All cases with miRL procedure was completed with only three preset robotic instruments. There was no conversion to thoracotomy. A complete resection (R0) for lung cancers were achieved in all 21 cases. The robotic instruments used in the control group other than miRL include monopolar spatula (N = 14), tip-up grasper (N = 10), clip applier (N = 7), needle driver (N = 6), Maryland bipolar grasper (N = 5), Cadiere forceps (N = 5), scissors (N = 3), and Debakey forceps (N = 1).

Discussion:

The robotic platform has several potential advantages over VATS including better dexterity, improved visualization, and faster learning curves. The maneuverability of robotic platform may also help perform complex lobectomy, such as sleeve resection, in a minimally invasive approach [1]. However, it is still debatable whether RL is cost-effective compared to VATS-L for early-stage lung cancers [2–5]. In many health systems, its cost poses a significant challenge in wider implementation.

There were some technical tips for using each preset robotic instrument in our strategy. First, the long bipolar dissector in the right arm can be used to dissect, grasp, coagulate, hold needles, and encircle relatively large veins. Before this strategy, we used a monopolar device or a short Maryland forceps for dissection and switched to the Cadiere forceps for encircling vessels or tying knots. The long bipolar dissector also replaced the needle driver. Second, the vessel sealer in the third arm can not only seal the small vessels but also grasp a sponge or the lung for retraction and cut the sutures. This has replaced the clipping device, tip-up grasper, and scissors. Finally, avoidance of insufflation with CO_2 did not pose significant challenge to our exposure.

There are limitations in this study. First, this is a retrospective study with a small sample size. Second, the absolute price cannot be generalized as each health system has different calculation methods. Nevertheless, as this reduction is directly related to significantly reduced consumable resources, the strategy would be beneficial in many health systems.

Conclusion:

With minimal RL strategy in our cohort, consumable cost for RL was significantly reduced while maintaining perioperative outcomes. Further evaluation with larger number of patients is warranted.

Declarations

Conflicts of interest statement:

Authors have nothing to declare.

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Ethics approval and consent to participate: This study was approved by the institutional review board (Ethical review board at the Japanese Red Cross Ashikaga Hospital: No 2019-43) on February 5, 2020 and consent was waived. All methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication: Not applicable.

Availability of data and materials: Data is available for review and the corresponding author should be contacted if necessary.

Authors' contributions: K.H. wrote the main manuscript text. All authors contributed to performing surgery, data acquisition and reviewed the manuscript.

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Figures

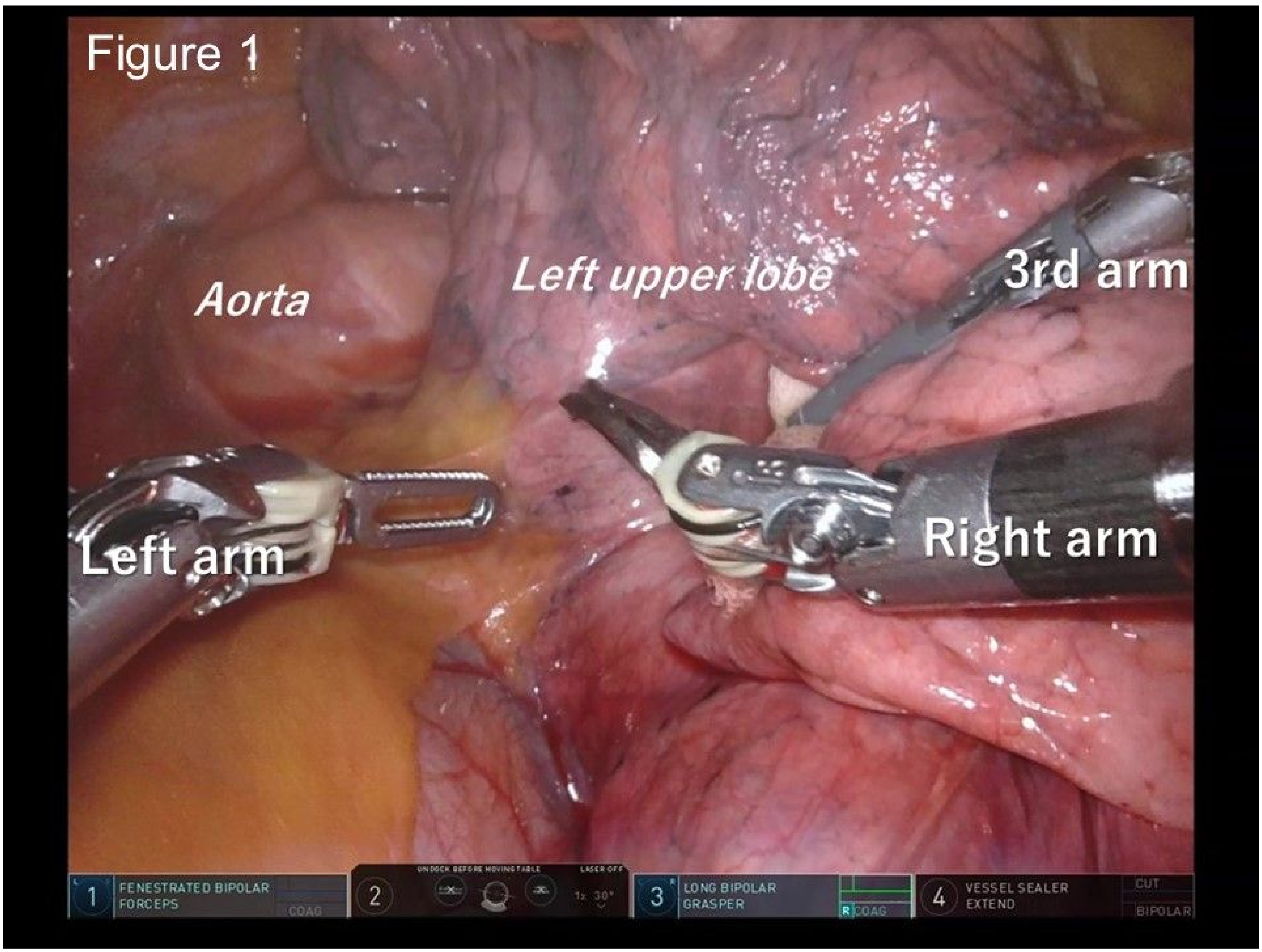

Figure 1

Three robotic instruments used in a robotic left upper lobectomy. Left arm: bipolar fenestrated. Right arm: long bipolar grasper. Third arm: vessel sealer.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- VideoforBMJsurgver2narrated.mp4