Whether Start Time of Elective Lung Surgery Impacts Perioperative Outcomes and Cost?

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Abstract

Background

Fatigue and long work hours of surgeons attracts increasing concerns in recent years. In clinical practice, most patients prefer to receiving surgery in the morning. So, we aimed to explore whether starting time is associated with perioperative outcomes and hospital cost for elective lung surgery.

Methods

A retrospective study was conducted on elective lung surgery patients between September 2019-November 2019. Patients were divided into “early start group” if surgery started before 4pm while “late start group” was after 4pm. Perioperative outcomes and total hospital costs were compared between two groups. Besides, multivariable logistic regression analysis was performed for further analysis.

Results

A total of 398 patients were finally enrolled for analysis in this study. Of all the cases, 295 patients were divided into early start group while 103 patients belonged to late start group. There were no differences in postoperative hospital duration, operation time, complication incidence and total hospital cost. In multivariable logistic regression analysis, surgery start late was still found not to be a risk factor.

Conclusion

In elective lung surgery, perioperative outcomes and cost were all similar between early start and late start surgery, it was not necessary to worry about surgery order for these patients.

Introduction

In general, fatigue and sleep deprivation are thought to result in low-efficiency work even mistakes. It has reached a consensus that circadian rhythm disturbances, overloaded work and fatigue could significantly increase accidents in transportation industry.[1] How about the impact in medical domain? Death of Libby Zion, a widely publicized case made giant social influence and then motivated revolution of resident education in America owing to the resident physician was found in long time overload work state.[2] And impacts of fatigue and sleep deprivation of physicians attracts more and more concern, a well-documented noun called “after-hour” effect is created which combined patient handoffs, resource limitations and differences in expertise of hospital staff after long duration work or in weekend time.[3] A study including surgical residents found fatigue and deprivation of sleep did decrease psychomotor and cognitive skills.[4] However, clinical studies investigated impacts of after-hour care have not reached a consensus, some conclude that late start surgery in the day could increase morbidity, mortality, cost and length of hospital stay,[5–9] while other have found no associations between outcomes and surgery start time.[10–13]

It is known that lung surgery amount has rapidly increased in recent years with more and more small nodules identified in China. However, there is only one study finding video-assisted lobectomy conducted in the late week could increase length of hospital stay.[9] Impacts of late start in the day still remain unclear concerning elective lung surgery. By the way, most Chinese have the habit to have a noon sleep and many official departments obey the rule of 8-hour work while a surgeon could discard both rules during a surgery day and result in deprivation of sleep and fatigue after 4:00 PM. Besides, many Chinese patients always required surgeon to arrange them the first to receive surgery, their routine thoughts are that surgeons are more energetic in the morning, but thoracic surgeons always think they could provide same high-quality medical service for all the patients. Under this circumstance, it was extremely proper to conducted this study to testify our hypothesis that late start lung surgery for patients was not associated with negative outcomes and provide an answer for the anxious patients.

Methods

Patients

All elective lung surgery patients were retrospectively collected between September 2019-November 2019 at department of thoracic surgery, west China hospital. Inclusion criterion: 1) lung surgery; 2) elective surgery; 3) age ≥ 18 years old; 4) normal preoperative renal and liver function; Exclusion criterion: 1) clinical data was sufficient; 2) lung surgery combined other organ surgery; 3) combined surgery (wedge resection, segmentectomy and lobectomy);4) urgent or emergent surgery of patients intended to receive elective surgery during hospitalization. All the patient information was extracted from electronic medical records system. Our institutional review board approved this study and patient consent was waved owing to retrospective nature of this study.

Study Design and Definitions

Point of skin incision making was viewed as the start time of one surgery. According to this definition of start time, surgery started between 8am and 4pm was defined as “early start” while “late start” namely started after 4pm for elective surgery. Start time of all the surgeries was between 8am to 9am in our hospital according to hospital rules and necessary preparation. One rule concerning elective surgery in our hospital is that surgery of the one before last case must be completed before 7pm unless the last case could not be received by the operation room in one day. All the surgeons in this study had abundant experience of lung surgery that they had performed lung surgery at least 400 cases and at least 5 years before this study. Primary outcomes contained postoperative hospital duration and total hospital cost, and these data could be collected in the electronic medical records system. Second outcomes included operation time, duration of chest tube, intraoperative bleeding volume, intraoperative conversion, duration of ICU time, complications (lung infection, pulmonary embolism, stroke, postoperative bleeding, incision infection, chylothorax, bronchial fistula, hoarseness, prolonged air leak, other site infection) and operative mortality (death occurred postoperative duration of in hospital or within 30 days after surgery), prolonged air leak was defined as 5 days. All the data were also collected from hospital electronic medical records

system by two doctors while definitions for postoperative events and complications were according to the Society of Thoracic Surgeons and the European Society of Thoracic Surgeons.

Statistical analysis

Concerning continuous data, mean ± standard deviation was adopted for normally distributed continuous variable while non-normally distributed continuous variables was demonstrated with median [interquartile range]. Categorical variables were showed as n. Student's t-test or Mann Whitney U-test were used to do comparison for continuous variables while Chi^2 test or Fisher's exact test for categorical variables according to specific data. Owing to all the baseline characteristics were comparable, we omitted application of statistical method of propensity-scored matching. Then multivariable logistic regression model was accepted for risk factor analysis, we included variables that P value ≤ 0.15 in baseline characteristics analysis, surgery start time and other probable factors clinically to do multivariable analysis. And Odds ratios (OR) are presented with 95% confidence intervals (CI) for logistic regressions. Multivariable analysis for postoperative complication was omitted owing to small sample of only 25 patients suffered complications. A P value of < 0.05 was considered statistically significant which was based on two-side test.

Results

Patient baseline and outcome comparison

A total of 398 patients were enrolled for analysis according to inclusion and exclusion criterion finally between September 2019-November 2019 at our department. Among these, 295 patients received lung surgery before 4pm while other cases in group after 4pm. As shown in Table 1, all the baseline characteristics including continuous variables and categorical variables were comparable between early start group and late start group. Only diabetes incidence seemed to be higher in early start group but without statistical significance and incidence of total comorbidity were also comparable between two groups. All outcomes were demonstrated in Table 2, concerning primary outcome, there was no difference in postoperative hospital duration (P = 0.363), total hospital cost tended to be higher in early start group but no statistical significance (P = 0.07). Besides, concerning second outcome, no differences were found in operation time, intraoperative bleeding volume, length of ICU time, length of chest tube time, complication incidence and conversion. Among all the patients, no death occurred within 30 days after surgery and only one patient received transfusion in early start group.

Table 1
Baseline characteristics comparison between early stat and late start group.

Variables	Early start group (n = 295)	Late start group (n = 103)	P
Age	56(49, 65)	56(48, 65)	0.771
BMI	22.66(20.96, 24.52)	22.89(21.09, 25.14)	0.442
Tumor size	1.4(1, 2.1)	1.2(0.9, 2.0)	0.162
Number of lymph nodes	5(4, 6)	5(3, 6)	0.364
Gender			0.462
Male	121	38	
Female	174	65	
Smoking			0.781
Yes	64	21	
No	231	82	
Alcohol			0.465
Yes	48	20	
No	247	83	
Comorbidities			0.788
Yes	93	31	
No	202	72	
Hypertension			0.959
Yes	68	24	
No	227	79	
Diabetes			0.072
Yes	28	4	
No	267	99	
Coronary artery disease			0.736
Yes	20	8	
No	275	95	
COPD			0.763
Yes	10	4	

Variables	Early start group (n = 295)	Late start group (n = 103)	P
No	285	99	
Kidney dysfunction			0.451
Yes	1		
No	294		
Liver dysfunction			1.000
Yes	2	0	
No	293	103	
Surgical range			0.335
Lobectomy	168	50	
Segmentectomy	83	35	
Wedge resection	44	18	
Surgical method			0.651
Minimally invasive surgery	291	101	
Open surgery	4	2	
Surgical approach			0.791
VATS	234	85	
UVATS	52	15	
RATS	5	1	
Open	4	2	
Histology			0.599
Benign	28	8	
Malignant	267	95	
ASA grade			0.316
1	2	2	
2	239	86	
3	54	15	

Table 2
Outcomes comparison between early stat and late start group.

Variables	Early start group (n = 295)	Late start group (n = 103)	P
Hospital duration	4(3, 5)	4(3, 5)	0.363
Cost	52967.43(46966.06, 61862.49)	51217.93(45122.32, 56414.69)	0.07
Operation time	90(70, 120)	86(60, 119)	0.408
Chest tube time	2(2, 4)	2(2, 3)	0.992
Intraoperative bleeding	20(20, 30)	20(20, 50)	0.356
ICU time	0(0, 0)	0(0, 0)	0.682
Complications			0.792
Yes	19	6	
No	276	99	
Lung infection			0.701
Yes	6	3	
No	289	100	
Air leakage			0.528
Yes	11	2	
No	284	101	
Chylothorax			1.000
Yes	2	1	
No	293	102	
Transfusion			-
Yes	1	0	
No	294	103	
Conversion			0.608
Yes	3	2	
No	292	101	
Mortality			-
Yes	0	0	
No	295	103	

Multivariable Postoperative hospital duration Analysis

All the patients were divided into two groups according to median of postoperative hospital duration, single variable comparison was demonstrated in supplement material 1. Then we conducted multivariable logistic analysis finding late start was not associated with increased postoperative hospital duration with an OR of 0.715 (95% Cl, 0.400-1.275, P = 0.255). Besides, there were no association between postoperative hospital duration and comorbidity, operation time, surgical range and surgical method. However, patients who expended higher total hospital cost had statistical significant longer postoperative hospital duration with an OR of 4.498 (95% Cl, 2.689–7.498, P□0.001). All were shown in Table 3.

Table 3
Multivariable logistic regression analysis of postoperative hospital duration.

Variables	OR	95%CI	P
Time of surgery			
Early start	1	-	-
Late start	0.715	0.400-1.275	0.255
Comorbidity			
No	1	-	-
Yes	1.351	0.805–2.269	0.255
Surgical range			
Wedge	1	-	-
Lobe	1.087	0.519–2.280	0.825
Segment	0.579	0.254–1.320	0.194
Surgical method			
Open	1	-	-
MIS	0.410	0.029–5.836	0.511
Complication			
No	1	-	-
Yes	-	-	0.998#
Operation time(min)			
≤89	1	-	-
>89	1.581	0.951–2.628	0.077
Cost			
≤53060	1	-	-
>53060	4.498	2.689–7.498	<0.001

Multivariable Cost Analysis

Then all the patients were divided into two groups according to median of total hospital cost, single variable comparison was demonstrated in supplement material 2, high hospital cost was associated with late start surgery, longer postoperative hospital duration, longer drainage time, suffering complication and comorbidity. However, as results of multivariable analysis demonstrated in Table 4, late start was not

associated with increased total hospital cost with an OR of 0.741 (95% CI, 0.444–1.239, P = 0.253). Comorbidity status, complication status and gender were also found no association with high total hospital cost. Only longer postoperative hospital duration and chest tube duration could significantly increase total hospital cost with OR of 2.779 (95% CI, 1.580–4.955, P 0.001) and 2.347 (95% CI, 1.410–3.977, P = 0.001), respectively.

Table 4
Multivariable logistic regression analysis of total hospital cost.

Variables	OR	95%CI	P
Time of surgery			
Early start	1	-	-
Late start	0.741	0.444–1.239	0.253
Comorbidity			
No	1	-	-
Yes	1.149	0.691–1.912	0.592
Smoking			
No	1	-	-
Yes	1.075	0.513–2.253	0.847
Alcohol			
No	1	-	-
Yes	1.062	0.510–2.213	0.872
Gender			
Male	1	-	-
Female	0.605	0.336–1.091	0.095
Complication			
No	1	-	-
Yes	-	-	0.998#
Postoperative duration(day)			
≤4	1	-	-
4	2.779	1.580–4.955	0.001
Chest tube duration			
≤2	1	-	-
2	2.374	1.410–3.997	0.001

Multivariable Operation Time Analysis

At last, all the patients were divided into two groups according to median of operation time, single variable comparison was demonstrated in supplement material 3, only more lymph node dissection was

significantly associated with long surgical time. In Table 5, multivariable logistic analysis demonstrated late start surgery did not impact operation time 0.927 (95% CI, 0.575–1.492, P = 0.754), so did variables of age, number of lymph nodes dissection and histology. However, lobectomy and segmentectomy significantly increased operation time with OR of 5.004 (95% CI, 2.428–10.310, P□0.001) and 3.467 (95% CI, 1.661–7.233, P□0.001) compared with wedge resection.

Table 5
Multivariable logistic regression analysis of operation time.

Variables	OR	95%CI	P
Time of surgery			
Early start	1	-	-
Late start	0.927	0.575–1.492	0.754
Surgical range			
Wedge resection	1	-	-
Lobectomy	5.004	2.428–10.310	□0.001
Segmentectomy	3.467	1.661–7.233	□0.001
Age			
≤56	1	-	-
□56	0.982	0.646–1.495	0.934
Number of lymph nodes			
≤5	1	-	-
□5	0.978	0.626–1.527	0.922
Histology			
Malignant	1	-	-
Benign	0.744	0.342–1.620	0.457
Surgical procedure			
Open	1	-	-
VATS	-	-	0.999#
UVATS	-	-	0.999#
RATS	-	-	1.000#

Discussion

To the best of our knowledge, there are few studies to explore outcomes of elective lung surgery patients and start time while many studies have explored the relationship between other organ surgery and outcomes. In this retrospective, a high surgery-volume center study of impact of start time and surgery outcomes, we found there was no difference in early start group and late start group concerning short outcomes and total hospital cost. Besides, we also revealed that late start also was not risk factor for longer postoperative duration, higher total hospital cost and longer operation time. This result was according with our primary hypothesis completely. By the way, complication incidence of lung surgery patients was decreased to an extremely low level in high surgery-volume center by all kinds of perioperative elaborate management and there were only 25 patients suffered postoperative complications in this study. Hence, we omitted to conduct multivariable analysis for postoperative complication owing to the extreme low sample. As for the cut-off time, we selected 4pm as some previous study,[7, 10, 14] another reason for selection of this time was that related labour law defines routine work duration of 8 hours and surgeons begin work 8am in our hospital.

As for the most common question of patients before surgery “May I be the first one to receive surgery in surgery order of tomorrow?” And now we could definitely answer “it is not necessary” loudly from results of this study. All the outcomes and total hospital cost were comparable between two groups, there are several possible reasons including surgeons could work continually with strong will, have a rest between surgery interval and all the surgery team could keep concentrating on patient status insuring surgery safely. Among baseline characteristics comparison between two groups, all the variables were comparable that procedure of conduction of propensity-scored match was omitted. Among the outcomes, no significant differences were found in all the variables. Besides, it is interesting that total hospital cost in the early start group was prone to be higher than late start group while it was no statistical significance. This result further proved late start for elective lung surgery did not have any negative impact even towards to cost less than start early which strongly testified our primary hypothesis. Similarly, surgery start time did not impact cost, postoperative hospital duration and operation time in multivariable analysis, though start late was associated with high cost and prone to result in longer postoperative hospital duration in single variable analysis. In summary, no association was found between elective lung surgery stat time and any outcome.

In elective thoracic surgery, Bao and his colleagues also find a later start time has no impact on both short- and long-term outcomes for patients undergoing minimally invasive McKeown esophagectomy via a propensity-scored match study[11]. Besides, studies concerning elective cardiac surgery also find no association between start time and perioperative outcomes, operative mortality, length of stay and total hospital cost.[10, 12, 13, 15] Studies above all agree same conclusion with this study, possible reasons including reasonable shift of assisted staff, sufficient supply of surgery related materials and surgeons’ strong will and concentration. However, some different voices do exist. A study enrolled 208 patients find lobectomy conducted in late in the week will significantly increase length of hospital stay than in early in the week.[9] Yount et. al also find late start cardiac surgery will increase absolute and risk-adjusted mortality.[5] Another study enrolled more than 100000 patients demonstrates that incidence of anesthetic

adverse events are more higher in late start group (P 0.0001) though bias exist in the study.[7] Similar to these studies, a study from New England Journal of Medicine finds patients with serious diseases have higher mortality when they are admitted on a weekend day than weekday. [16] Besides, medical education studies of fatigue and sleep deprivation have also found surgical skills of residents could be affected by these unfavorable situations.[4, 17] These studies believe these unfavorable outcomes resulted from all aspects including fatigue of both surgeons, anaesthetists and nurses and lack of sources. However, in large medical center like our center, sources of materials supply will always be sufficient, nurses and anaesthetists also have proper shift at fixed time, so outcomes in different level of hospitals could also be different.

There were several limitations existing in this study. First of all, as a retrospective study, inherent shortcomings could decrease the reliability degree of evidence. Second, a sample of about 400 patients was relatively small and more multi-center, large sample and prospective studies could be beneficial in future. Third, incidence of postoperative complication was too low to do further analysis for the relationship with start time of lung surgery. Forth, patients enrolled in this study contained different histology and different surgery approach which could result in bias, but the variables were comparable in different groups which made the results still reliable. Finally, this study only enrolled elective lung surgery, association start time and urgent or emergent lung surgery is needed further investigated in future.

Conclusion

In this study, we demonstrated there were no differences concerning postoperative hospital duration, hospital cost, operation time, complication incidence and postoperative mortality between surgery started before and after 4pm. Besides, surgery started late also was identified as no risk factors for outcomes by multivariable analysis. Hence, this study suggested patients could wait for surgery silently without any worry and provided evidence for surgeons to properly increase surgery amount in high-volume surgery center.

Abbreviations

ICU=intensive care unit, BMI=body weight index, ASA=American society of anesthesiology, VATS=video-assisted thoracoscopic surgery, UVATS=uniportal video-assisted thoracoscopic surgery, RATS=robot-assisted thoracoscopic surgery, OR=odds ratio, 95% CI=95% confidence interval.

Declarations

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Contributions

(I) Conception and design: YD Lin, GH A-Lai; (II) Administrative support: YD Lin; (III) Provision of study materials or patients: JR Hu, GH A-Lai; (IV) Collection and assembly of data: ZJ Xu, TN Song, ZG, Zhuo; (V) Data analysis and interpretation: X Shen, P Yao; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

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Ethics Declarations

Ethics approval and consent to participate

All methods were performed in accordance with the Declaration of Helsinki. This study was approved by the Ethics Committee of West China Hospital. Written consent was acquired from all included patients.

Consent for publication

Not Applicable.

Availability of data and material

The datasets of this study will become available from the corresponding author on reasonable request.

Competing interests

No interest conflicts to announce.

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