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Original Article

Video-assisted thoracoscopic Ivor-Lewis esophagectomy does not reduce the incidence of postoperative atrial fibrillation

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Abstract: The objective here is to determine the incidence of atrial fibrillation after video-assisted thoracoscopic Ivor-Lewis esophagectomy (VATE) and determine whether VATE reduces incidence of atrial fibrillation compared with open Ivor-Lewis esophagectomy (OE). We conducted a retrospective study to identify patients undergoing Ivor-Lewis esophagectomy who were in sinus rhythm preoperatively and received no prophylactic antiarrhythmics before surgery. Patients undergoing VATE were age and gender matched with those undergoing open thoracotomy. After matching, there were 158 patients in each group. Postoperative atrial fibrillation occurred in 12% of patients (15/122) undergoing VATE and 16% of patients (20/122) undergoing thoracotomy. Overall, postoperative complications were similar between the two groups. Patients with atrial fibrillation were older in both VATE and OE groups ($P<0.05$). Length of stay for patients with atrial fibrillation was greater in both VATE ($P<0.05$) and OE groups ($P<0.05$). In summary, atrial fibrillation after Ivor-Lewis esophagectomy occurred with equal frequency between VATE and OE. This may be due to autonomic denervation and stress-mediated neurohumoral mechanisms which are responsible for the pathogenesis of postoperative atrial fibrillation. Prophylaxis regimens against atrial fibrillation should be applied.

Keywords: Minimally invasive surgery, video-assisted thoracoscopic surgery, Ivor-Lewis esophagectomy, atrial fibrillation

Introduction

Postoperative atrial fibrillation is seen in about 20% of elderly patients who underwent Ivor-Lewis esophagectomy for esophageal carcinoma [1-8]. Postoperative atrial fibrillation is commonly associated with other postoperative cardiovascular complications such as heart failure and acute coronary syndromes, resulting in greater risk of ischemic stroke in those who remain in persistent atrial fibrillation. Advanced age is an independent risk factor for postoperative atrial fibrillation after thoracic surgery [1-6]. The proportion of individuals aged more than 65 years in China is increasing, which suggests that the number of elderly patients with esophagus carcinoma requiring radical Ivor-Lewis esophagectomy will increase recently [9].

The technique of video-assisted thoracoscopic Ivor-Lewis esophagectomy (VATE) for esophagus cancer was first reported in the early 1990s. VATE has been shown to be associated with a better cosmetic result, shorter chest drain, decreased acute postoperative complication and earlier recovery compared with open Ivor-Lewis esophagectomy (OE) [10-13]. Because of less trauma and oncologically acceptable, the use of VATE for esophagus cancer has been slowly increasing. Some thoracic surgeons believe that VATE may result in less rates of postoperative morbidity when compared with OE, especially in elderly patients who underwent Ivor-Lewis esophagectomy [14-16]. However, only few studies have analyzed the incidence of postoperative atrial fibrillation after VATE and compared the rate of atrial fibrillation after VATE with OE [1, 2]. We decided to

Table 1. Preoperative characteristics

	VATE (*n*=158)	OE (*n*=158)	*P* value
Age (years)	69 (48-79)	69 (46-79)	0.946
Sex			0.641
Male	135	132	
Female	23	26	
Comorbidity			0.982
Previous ACS	6	7	
Hypertension	21	19	
Diabetes Mellitus	11	10	
COPD	13	14	
Stable angina	10	8	
Preoperative serum potassium (mmol/L)	4.9 (3.7-5.3)	4.7 (3.6-5.2)	0.560
Preoperative serum calcium (mmol/L)	2.4 (2.3-2.5)	2.4 (2.3-2.5)	0.681
Taking beta-blockers *n* (%)	28 (17.7)	30 (19.0)	0.771
Taking calcium channel blockers *n* (%)	18 (11.4)	16 (10.1)	0.717
Neodjuvant therapy *n* (%)	13 (8.2)	15 (9.5)	0.692

ACS: acute coronary syndrome; COPD: chronic obstructive pulmonary disease; VATE: Video-assisted thoracoscopic esophagectomy; OE: open esophagectomy.

Table 2. Postoperative data

	VATE (*n*=158)	OE (*n*=158)	*P* value
Operative time (min)	240 (210-320)	200 (190-250)	0.000
Overall complications *n* (%)	33 (20.9%)	41 (25.9%)	0.288
Atrial fibrillation	22	27	0.437
Atelectasis	2	2	1.000
Pneumothorax	1	2	1.000
Pneumonia	4	5	1.000
Pulmonary embolism	1	1	1.000
Recurrent laryngeal nerve injury	1	1	1.000
Anastomosis leakage	1	2	1.000
Heart failure	1	1	1.000
Postoperative stay (d)	10 (8-20)	14 (7-26)	0.000

VATE: Video-assisted thoracoscopic esophagectomy; OE: open esophagectomy.

perform a case-control study analyzing the rates of postoperative atrial fibrillation in patients undergoing Ivor-Lewis esophagectomy to determine whether there is an advantage afforded by the use of VATE.

Patients and methods

This study complied with the Declaration of Helsinki rules. This retrospective research was approved by the Ethics Committee of The People's Hospital of Rizhao. The need for informed consent from all patients was waived because of retrospective nature.

We conducted a retrospective review of all patients who had an Ivor-Lewis esophagectomy with two-field lymphadenectomy (mediastinal and abdominal lymph node dissection) for resectable thoracic esophageal carcinoma in a prospective database at The People's Hospital of Rizhao from January 2010 to January 2014. Patients were selected based on the following eligibility criteria: (1) received radical Ivor-Lewis esophagectomy with two-field lymphadenectomy (VATE or OE) for thoracic esophageal carcinoma; (2) in sinus rhythm before surgical resection; (3) oral taking beta-blockers or calcium channel blockers preoperative for hypertension or coronary artery disease; and (4) no extended resection. Patients were excluded based on the following criteria: (1) oral taking class I or III antiarrhythmic drugs, or placed on prophylactic medications postoperatively; or (2) incomplete medical data. A case-control study analysis was performed to select two comparable groups for analysis in this study. Patients were matched on the basis of age and gender. After matching, there were 96 patients in the VATE group (patients underwent VATE) and 96 patients in the OE group (patients underwent OE. After matching, there were 316 patients eligible for analysis, 158 patients in each group.

In all patients, radical Ivor-Lewis esophagectomy and two-field lymph node dissection were performed either by VATE or OE. The detail of VATE and OE has been described previously [17]. After surgery by VATE or OE, all patients remained in the intensive care unit on continu-

Table 3. Postoperative atrial fibrillation on postoperative stay

	VATE with atrial fibrillation (*n*=22)	VATE without atrial fibrillation (*n*=136)	*P* value	OE with atrial fibrillation (*n*=27)	OE without atrial fibrillation (*n*=131)	*P* value
Age (years)	74 (60-79)	66 (48-69)	0.010	72 (63-79)	65 (46-68)	0.016
Postoperative stay (d)	13 (11-20)	9 (8-16)	0.023	17 (12-26)	13 (7-20)	0.001

VATE: Video-assisted thoracoscopic esophagectomy; OE: open esophagectomy.

ous electrocardiogram (ECG) monitoring on the first postoperative day. Then the patients were transferred to thoracic ward. When available, continuous electrocardiogram monitoring was continued on the thoracic ward for an additional 96 hours or more. ECG monitoring was discontinued when the patient remained in normal sinus rhythm for 108 hours postoperatively. Episodes of postoperative atrial fibrillation were identified by 12-lead ECG or continuous ECG monitoring. Patients were considered to have atrial fibrillation if the episode lasted more than 5 minutes by continuous ECG monitoring or required intervention.

For statistical analysis, SPSS 13.0 for windows version (SPSS Inc., Chicago, IL, USA) was used. Data were presented as mean and standard deviations for variables following normal distribution and were analyzed by *t* test. For variables following non-normal distribution, results were expressed as median and range and were compared by nonparametric test. Differences of semi-quantitative results were analyzed by Mann-Whitney *U*-test. Differences of qualitative results were analyzed by chi-square tests or Fisher exact test where appropriate. Two sides $P<0.05$ were considered statistically significant.

Results

The patients in each group were well matched in terms of preoperative clinical data (**Table 1**). The presence of comorbidity, preoperative serum electrolyte values, and the proportion of patients taking beta-blockers or calcium channel blockers in each group were similar.

The operative time was longer in the VATE group ($P=0.000$). The overall rate of postoperative atrial fibrillation in all 316 patients undergoing Ivor-Lewis esophagectomy was 15.5% (49/316), and there was no difference in rates between the two groups (**Table 2**). Postoperative atrial fibrillation was observed in 22 of 158 patients (13.9%) who underwent VATE and compared with 27 of 158 patients (17.1%) who underwent OE. Among patients who were older than 65 years, postoperative atrial fibrillation occurred in 21 of 142 (14.8%) in the VATE group and in 25 of 139 (18.0%) in the OE group. A total of 74 of 316 patients (23.4%) had postoperative complications, without significant difference between the VATE group and OE group. There was no perioperative 30-day mortality in the two groups. The length of postoperative hospital stay of the patients who underwent OE was longer than that of the patients who underwent VATE ($P=0.000$) (**Table 2**).

Patients with postoperative atrial fibrillation were older than those without atrial fibrillation both within the VATE group ($P=0.010$) and the OE group ($P=0.016$). The length of postoperative hospital stay was significantly greater for patients with atrial fibrillation compared with patients who did not have atrial fibrillation regardless of whether they had a VATE approach ($P=0.023$) or an OE approach ($P=0.001$) (**Table 3**).

Discussion

The main finding of our study is that the rate of postoperative atrial fibrillation after Ivor-Lewis esophagectomy for esophagus cancer was similar between the VATE and OE approach. The incidence of postoperative atrial fibrillation in our series was 15.5%, which was consistent with previous reports [1-8]. The mechanisms of postoperative atrial fibrillation after esophagectomy are still unclear. Previous reports showed that stress-mediated neurohumoral mechanisms or autonomic denervation may be the reason of postoperative atrial fibrillation after esophagectomy [18, 19]. We also found that postoperative atrial fibrillation contributes to a longer hospital stay when compared with

patients without atrial fibrillation undergoing the same operative approach (VATE or OE).

Advocators of VATE emphasize the benefits of decreased blood loss, less acute postoperative pain, shorter chest tube duration, and earlier recovery. In addition, some reports have showed that minimally invasive esophagectomy results in fewer postoperative complications in high-risk patients. One of the most common postoperative cardiac complications after Ivor-Lewis esophagectomy is supraventricular arrhythmia, which may result in an extended hospital stay and a greater risk of ischemic stroke or transient ischemic attack [20, 21]. Several large retrospective series have analyzed the incidence of and risk factors for postoperative atrial fibrillation after non-cardiac thoracic resections, and the rate was about 20% [22-24]. The surgical approach in the majority of these studies above mentioned was open thoracotomy. In contrast, Luketich JD (1) and his hospital colleagues reported that the rate of postoperative atrial fibrillation in 222 esophagus cancer patients undergoing minimally invasive Ivor-Lewis esophagectomy was 11.7%. Mamidanna R [2] and colleagues published the largest series of 1155 minimally invasive esophagectomy and reported a postoperative atrial fibrillation rate of 8.8%. These data suggest that a minimally invasive esophagectomy approach, perhaps by fewer traumas, may result in a decreased incidence of postoperative atrial fibrillation. The higher incidence of postoperative atrial fibrillation in our series may be due to the differences in atrial fibrillation definitions, monitoring techniques, and prevention strategies in each of these studies above mentioned.

There were a few interesting trends when comparing the VATE and OE groups with respect to other postoperative outcomes. As expected and consistent with other literatures [10-13], the length of postoperative stay for patients undergoing VATE was significantly shorter than their patients undergoing OE. This may partly explain the reason why the median postoperative stay for patients undergoing VATE who had atrial fibrillation was still shorter than that of patients undergoing OE without atrial fibrillation. The trend in the rate of overall and pulmonary complications seemed to favor the VATE group, but this result did not reach statistical significance because of small sample size. Additional studies looking into this issue with a larger sample size might be useful.

There are several strengths of our study. First, we evaluated a common postoperative problem after Ivor-Lewis esophagectomy in a homogeneous population. Second, the definition of postoperative atrial fibrillation was systematic, consistent, and clinically relevant in our series.

All studies have limitations. First, this study is based on single-center analysis and based on retrospective analysis. Second, although the results suggest that the operative approach is not a significant factor in the pathogenesis of postoperative atrial fibrillation, the data offer little additional insight to further our understanding of mechanisms responsible for postoperative atrial fibrillation. These limitations should be taken into account when interpreting the results.

In summary, postoperative atrial fibrillation is a common cardiac complication in older patients undergoing Ivor-Lewis esophagectomy and contributes to prolonged postoperative hospital stay, higher health care costs, and the known risk for stroke events. The use of a video-assisted thoracoscopic approach does not decrease the incidence of postoperative atrial fibrillation after Ivor-Lewis esophagectomy when compared with open resection. Patients deemed to be high risk preoperatively should be considered for proven prophylactic therapy regardless of the planned operative approach.

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Disclosure of conflict of interest

None.

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