

Analysis of the relationship between deep venous catheter-related infection and post-operative complications in patients receiving minimally invasive esophagectomy

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Abstract

Objective The aim of the study was to evaluate catheter-related infection rate (CRIR) for patients receiving minimally invasive esophagectomy (MIE), to identify the optimal catheterization approach and relationship between CRIR and post-operative complications.

Methods In total, 168 patients with esophageal carcinoma and undergoing MIE combined with pre-operative deep venous catheterization (DVC) were analyzed in our institution (Qingdao Municipal Hospital, China), from 2014 to 2018. After completing DVC, catheter-tips together with intraductal venous blood samples were sent to the microbiology lab for bacterial strain culture. CRIR was statistically evaluated for the following clinical variables: gender, age, smoking status, drinking status, past history, tumor location, histologic grade, pathological T, N, and M category, anastomotic location, anastomotic leakage, anastomotic stricture, chylothorax, pneumonia, recurrent laryngeal nerve (RLN) injury, reflux esophagitis, catheterization site, and catheter-locking days.

Results Among the 144 patients recruited in our study, 105 catheters were inserted into the jugular vein and 39 catheters into the subclavian vein. The median age of these patients was 63 years (range: 42–79 years), and the median catheter-locking period was seven days (range: 4–21 days). Four catheters were identified with three types of strain colonizations, including *Staphylococcus epidermidis*, *Staphylococcus aureus* and *Blastomyces albicans*. Statistical data showed that patients diagnosed with catheter-related infection were likely to incur anastomotic leakage (66.67%, $P < 0.001$) and pneumonia (27.27%, $P < 0.001$); features such as tumors located in the upper esophagus (13.6%, $P = 0.003$), and over seven catheter-locking days (10.00%, $P < 0.001$) were attributed to a high CRIR.

Conclusion Although both jugular and subclavian veins can be catheterized for patients with MIE, DVC is associated with more than seven catheter-locking days and upper esophagectomy, due to high CRIR. Furthermore, catheter-related infection is related to anastomotic leakage and pneumonia.

Key words: deep venous catheterization (DVC); catheter-related infection (CRI); minimally invasive esophagectomy (MIE); complications

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Deep venous catheterization (DVC) is a dependable and convenient approach for medical staff to perform safety infusion, anti-shock, and surveillance procedures. The common sites of insertion include the femoral, jugular and subclavian veins [1–2]. Despite remarkable advantages, the drawbacks of this technique cannot be ignored. Catheter-related bloodstream infection (CRBSI)

is one of the most common complications of DVC, and often results in prolonged hospitalization, increasing costs, and even a high risk of mortality [3]. With the popularization of Enhanced Recovery After Surgery (ERAS), many scholars recommended that reducing catheter-days and selecting a suitable insertion site can alleviate the complications of DVC [4–5]. However, there

is limited research attention regarding catheter-related infection rates (CRIR) in patients undergoing minimally invasive esophagectomy (MIE).

Therefore, we conducted the present study to evaluate CRIR in different insertion sites, in order to identify the relationship between CRIR, post-operative complications and eligible local insertion sites for patients with MIE.

Materials and methods

Initially, 168 cases from 2014 to 2018 treated in the Department of Cardiothoracic Surgery of our institution (Qingdao Municipal Hospital, China) were screened, and all underwent MIS and pre-operative DVC. To minimize confusion, we designed a brief methodology to confirm the type of catheter-related infection, by identifying strain colonization of the catheter-tip and intra-catheter blood. Furthermore, some patients not meeting the criteria were excluded.

Exclusion criteria

Some necessary exclusion criteria were applied in order to streamline and enforce the research. The details were as follows: (1) Patients owing to multiple catheters during hospital stay; (2) Occurrence of unexpected exfoliation of catheter; (3) Catheter-based mechanical complications (e.g. artery injury, local hematoma and pneumothorax), and deep-vein thrombosis.

Process of catheterization and identification of strains

Under the full shield of sterilization, including surgical hand antisepsis, disposable surgical long-sleeved gowns, sterile gloves, caps, and masks for manipulators, as well as sterile drapes, antiseptics and dressings for patients, catheterization was completed using the Seldinger technique [6]. In addition, catheters were removed based on the nutritional status and emergence of post-operative complications. Given that early enteral nutrition support was beneficial to improve the patient's condition and conserve medical expenses, catheters were removed when normal oral feeding had resumed.

Catheter-tips, together with intraductal venous blood, were sent to the microbiology lab for bacterial strain culture. Any type of bacterium or fungus confirmed by the clinical laboratory was recorded.

Statistical analysis

After data collection, the relevant variables were categorized and statistical differences among categorical variables were analyzed using Pearson's chi-square test. A two-sided P value less than 0.01 was considered statistically significant. All statistical analyses were performed using SPSS version 19.0.

Results

A total of 144 catheter samples were obtained for our study. In total, 105 catheters were inserted into the jugular vein and 39 catheters into the subclavian vein. For all patients (115 males and 29 females) receiving catheterizations, the median age was 63 years (range: 42–79 years), and the median catheter-locking days was seven (range: 4–21 days). Four catheters were confirmed to possess three types of strain colonization, including *Staphylococcus epidermidis*, *Staphylococcus aureus* and *Blastomyces Albicans*, which were identified in the tip of the catheters or intra-catheters. The detailed relationship between catheter-tip infections and post-operative complications for all patients is listed in Table 1. The statistical analysis revealed that patients diagnosed with catheter-related infection were likely to experience anastomotic leakage (66.67%, $P < 0.001$), pneumonia (27.27%, $P < 0.001$), features such as tumors located in the upper esophagus (13.6%, $P = 0.003$), and over seven catheter-locking days (10.00%, $P < 0.001$), which were attributed to a high CRIR.

Discussion

With the popularization of the DVC technique, perioperative fluid infusion and central venous pressure monitoring has become simple and reliable [2, 7]. Most surgeons and anesthetists consider the subclavian vein as a primary insertion site, because of its low CRIR. However the risk of mechanical complications such as arterial injury, obvious hematoma, and pneumothorax are greater than the jugular vein insertion site [1, 8]. The Centers for Disease Control and Prevention guidelines for preventing intravascular catheter-related infections recommend to “use a subclavian site, rather than a jugular or a femoral site, in adult patients” [9]. However, research has revealed that subclavian vein catheterization is associated with a high incidence rate of mechanical complications [2, 4, 8]. A large-scale multicentric randomized trial, which analyzed a total of 3471 catheters in 3027 patients using three procedures, demonstrated that subclavian-vein catheterization was associated with a lower risk of bloodstream infection and deep vein thrombosis, and a higher risk of pneumothorax, compared to jugular-vein or femoral-vein catheterization [8]. In our study, there was no significant difference between subclavian vein and jugular vein catheterization in CRIR, but prolonged catheter-locking days and upper esophagectomy resulted in high CRIR. Therefore, we consider it beneficial for patients with MIE to receive short-term catheterization, especially for those with upper thoracic esophagectomy.

Under the guidance of ERAS, the early removal of catheters and performing enteral nutrition support

Table 1 The relationship between the catheter-tips infection and post operative complications in patients receiving MIE

Variable	<i>n</i>	Catheter-related infection rates (%)	<i>P</i>	Variable	<i>n</i>	Catheter-related infection rates (%)	<i>P</i>
	144	2.78			144	2.78	
Gender			0.806	AJCC stage			0.052
Male	115	2.61		PI stage	27	0	
Female	29	3.45		PII stage	59	6.78	
Age (years)			0.620	PIII stage	58	0	
≤ 65	91	3.30		Anastomotic location			0.330
> 65	53	1.89		Neck	27	0	
Smoking status			0.473	Chest	117	3.42	
Never	48	4.17		Anastomotic leakage			< 0.001
Ever	96	2.08		No	141	1.42	
Drinking status			0.208	Yes	3	66.67	
Never	104	3.85		Anastomotic stricture			0.767
Ever	40	0		No	141	2.84	
Past history			0.284	Yes	3	0	
No	70	4.29		Chylothorax			0.700
Yes	74	1.35		No	139	2.88	
Tumor location			0.003	Yes	5	0	
Upper	22	13.64		Pneumonia			< 0.001
Middle	105	0.95		No	133	0.75	
Lower	17	0		Yes	11	27.27	
Histologic grade			0.184	RLN injury			0.623
G1	32	0		No	138	2.90	
G2	79	5.06		Yes	8	0	
G3	33	0		Reflux esophagitis			0.767
Pathological T category			0.362	No	141	2.84	
PT1	21	0		Yes	3	0	
PT2	20	0		Catheterization site			0.924
PT3	81	4.94		Jugular vein	105	2.86	
PT4	22	0		Subclavian vein	39	2.56	
Pathological N category			0.428	Catheter-locking days			0.001
PN0	86	4.65		≤ 7 days	104	0	
PN1	26	0		> 7 days	40	10.00	
PN2	20	0					
PN3	12	0					

Note: MIE: minimally invasive esophagectomy; RLN: recurrent laryngeal nerve

could minimize the risk of CRBSI. A meta-analysis conducted by Chinese scholars revealed that early oral-feeding or nasogastric feeding is superior to DVC infusion when alleviating CRIR in patients with acute pancreatitis [10]. After analyzing the variables of MIE patients, we found that high CRIR results in a high risk of anastomotic leakage and pneumonia, attributed to blood stream infection by systemic veins, arising from strain colonization of catheter-tips. Thus, it is essential to strictly manage catheter-locking days, not only to lower the risk of catheter-tip infection, but also strengthen enteral nutrition.

Some limitations of this research cannot be ignored. Firstly, the homogeneousness of retrospective data was difficult to guarantee accurately and therefore some deviation exists in the statistical results. Furthermore, the absence of a peripheral blood test for recruited

samples may reduce the authority of our study. However, our research still has importance: (a) both jugular and subclavian veins can be catheterized for patients with MIE, (b) DVC for more than seven days and upper esophagectomy leads to high CRIR, and (c) MIE patients with catheter-related infection are at risk of serious post-operative complications. We hope more large-scale, randomized controlled trials are carried out in the future to further verify these issues.

Conflicts of interest

The authors indicated no potential conflicts of interest.

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