**INTRODUCTION**

Surgery is the most important treatment measure for early esophageal cancer. Chylothorax after oesophagectomy is a potentially dangerous complication with a rate of approximately 2.7 - 3.8%.\(^1\) Caused by the damage to thoracic ducts and/or its branches, chylothorax is defined as the leakage of lymphatic fluid (containing lymphocytes, immunoglobulins, and various biological enzymes) that is enriched with chylomicrons and lipids (including lipid-soluble vitamins, chylomicrons, and triglycerides) into the thorax.\(^2\) Dougenis et al. suggested that the thoracic duct should be routinely ligated to reduce the incidence of postoperative chylothorax.\(^3\) Others raised an objection that prophylactic ligation of the thoracic duct could not only reduce the occurrence of postoperative chylothorax, but also had unfavourable impact on overall survival in patients with resectable oesophageal cancer.\(^4,5\) The point of contention, therefore, is whether ligation of the thoracic duct influence the absorptive function, which is very important to effect the enteral nutrition.\(^6\) Mass ligation of thoracic duct minimizes the risk of postoperative chylothorax in patients who underwent transthoracic oesophagectomy, without any other major or minor intraoperative or postoperative complications.\(^7\) However, having no obvious complications does not mean having no influence on the absorptive function. Thoracic duct narrowing has been proved as one kind of simple and safe surgical procedure in restraining weight gain in rats.\(^8\) It is very important to figure out whether ligation of thoracic duct influences the absorptive function, according to which different nutritional strategies were selected. D-xylose absorption test, which has been widely used as an index of small intestinal function.\(^9,10\) The purpose of this study was to determine if ligation of the thoracic duct during oesophagectomy can lead to malabsorption, using D-xylose absorption as an immediate one as use.

**METHODOLOGY**

The present study included early lower segment esophageal cancer patients, with normal liver and kidney function, from August 2014 to December 2015. The patients underwent left transthoracic oesophagogastrotomy under the aortic arch by the same group of surgeons. All patients were randomized into two groups: no-ligation group (n=30, 50%) and ligation-group (n=30, 50%), according to the management of the thoracic duct during surgery. Their average age was 58 years. The study has been approved by the Committee on Medical

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**ORIGINAL ARTICLE**

Effect of Ligation of the Thoracic Duct During Oesophagectomy on the Absorption of D-xylose

Rui-feng Yang\(^1,2\), Zhong-min Jiang\(^1\), Run-qi Zhang\(^2\), Bing Yu\(^3\), Xiao-hong Wang\(^4\) and Peng Wang\(^2\)

**ABSTRACT**

Objective: To assess if prophylactic thoracic duct ligation during oesophagectomy influences the absorptive function of oesophageal cancer patients.

Study Design: Randomized controlled trial.

Place and Duration of Study: Department of Thoracic Surgery, Tai’an City Central Hospital, Tai’an, from August 2014 to December 2015.

Methodology: Based on the management of the thoracic duct during oesophagectomy, 60 patients were randomized into two groups. D-xylose absorption test was used to evaluate the absorptive function. The two-independent-samples t-test was employed for statistical analysis with statistical significance at p < 0.05.

Results: The serum D-xylose concentration of ligation-group was significantly lower than that of no-ligation group on the first day after operation, (t=2.82, p=0.0066). However, there was no significant differences between them even before operation (t=1.34, p=0.1849).

Conclusion: Ligation of the thoracic duct during oesophagectomy immediately affected the absorption of D-xylose, which may lead to malabsorption in the long run.


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1 Department of Thoracic Surgery, Qianfoshan Hospital of Shandong Province, Shandong University, Ji’nan, Shandong 250012, China.
2 Department of Thoracic Surgery / Colorectal Surgery\(^3\) / Digestive System\(^4\), Tai’an City Central Hospital, Tai’an, Shandong 271000, China.

Correspondence: Dr. Zhong-min Jiang, Department of Thoracic Surgery, Qianfoshan Hospital of Shandong Province, Shandong University, Ji’nan, Shandong 250012, China.

E-mail: xwk_yrf@163.com

Received: March 28, 2016; Accepted: March 14, 2017.
Ethics of Taian City Central Hospital, and written informed consent was obtained from all patients.

During the transthoracic oesophagectomy, thoracic duct was identified between the azygos vein and descending aorta about 2 cm above the level of the diaphragmatic hiatus with large curved forceps after completion of the oesophago gastric anastomosis, and double ligated with a non-resorbable 0 polyester ligature.

All patients were kept in fasting from 22:00 to 6:00 on the morning a day before operation. After taking blood sample, 5.0 g D-xylose dissolved in 200 ml warm water were orally administered. One hour later, blood samples were taken again. In all patients, a duodenal feeding tube was used. No energy liquid was infused from 22:00 on the operation day to 6:00 next morning. After taking blood samples, 5.0 g D-xylose dissolved in 200 ml warm water were given by nasal feeding. One hour later, blood samples were taken again.

All analyses were performed using the computer-assisted SAS 8.0. Qualitative variables were presented with percentages, and quantitatives were summarized as mean with standard definition. Linear-regression analysis was used to calculate regression equation between concentration of D-xylose solution and corresponding absorbance. Two-independent-samples t-test analyses were performed to compare mean blood D-xylose concentrations between two groups and mean blood D-xylose concentrations before and after operation. P-value of < 0.05 was considered significant.

RESULTS

Table I shows different concentration of D-xylose solution and corresponding absorbance. The relationship between D-xylose soluble concentration and absorbance ability was linear, with the lower-limit of quantitation for D-xylose soluble concentration was 0.025 mg/ml and the upper limit of quantitation was 0.2 mg/ml, as is shown in Figure 1. The linear regression equation was Y=2.3795X+0.0469, in which Y was absorbance and X was the concentration of D-xylose (mg/ml). The coefficient of determination was 0.9982.

The blood D-xylose concentrations of two groups before and after operation are shown in Table II. There was significant differences for the blood D-xylose concentrations between two groups after operation (t=2.82, p=0.0066). However, there was no significant differences between them even before operation (t=1.34, p=0.1849). Whether the thoracic duct is ligated or not, the blood D-xylose concentrations were lower than that before operation.

<table>
<thead>
<tr>
<th>D-xylose concentration (mg/ml)</th>
<th>0.025</th>
<th>0.05</th>
<th>0.075</th>
<th>0.1</th>
<th>0.125</th>
<th>0.15</th>
<th>0.175</th>
<th>0.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absorbance</td>
<td>0.106</td>
<td>0.16</td>
<td>0.228</td>
<td>0.285</td>
<td>0.345</td>
<td>0.417</td>
<td>0.46</td>
<td>0.516</td>
</tr>
</tbody>
</table>

DISCUSSION

Postoperative chylothorax is one of the most dangerous complications of oesophagectomy. Once some scholars suggested that the thoracic duct should be routinely ligated to reduce the incidence of postoperative chylothorax.3 In the meantime, another people raised an objection that prophylactic ligation of the thoracic duct could not only reduce the occurrence of postoperative chylothorax, but also has unfavourable impact on overall survival in patients with resectable oesophageal cancer.4,5 Thoracic duct should be ligated when suspected to be damaged during operation. The focal problem is whether ligation of the thoracic duct will influence the absorptive function, according to which different nutritional strategies are selected. The lymphatic system is responsible for the absorption of fats from the digestive system, and conveying most of ingested fat to the blood stream.11 From the anatomical point of view, all the lymphatic drainage from the lower half of the body converges in the abdomen to enter the thoracic duct. After ligation of thoracic duct, the hepatic lymphatic collateral circulation will not establish immediately, which indicates lymph will silt up. The lymphatic system plays a central role in controlling the concentration of proteins in the interstitial fluids, the volume of interstitial fluid and the interstitial fluid pressure. Therefore, lymphostasis of small intestine can lead to mucosal edema, which can affect absorptive function seriously.12 Toshihiko Neyazaki’s test showed that after ligation of thoracic duct, immediate disturbances were seen in the lymphatic system, including enlargement of nodes and lymphatics; even protein-losing enteropathies were provoked.13

With the purpose to determine if the thoracic duct ligation can lead to malabsorption, the authors adopted a simple and accurate method. D-xylose test for intestinal absorption has been widely used and constantly perfected.14 D-xylose is not revolved in body metabolism and is excreted through kidney as a kind of pentose after absorbed by jejunum, so the blood or urinary D-xylose concentration can reflect the absorptive function of small intestine. Majority of studies appear to favour serum D-xylose measurements over urinary D-xylose excretion to screen adult and paediatric patients for small intestinal malabsorption.15-17

Early lower esophageal cancer patients, ranging in age from 46 to 72 with average age of 58 years, were selected for this study. All patients were male, whose preoperative liver and kidney function were normal. According to the management of the thoracic duct during surgery, all patients were randomly divided into ligation group and no-ligation group, who had received left
D-xylose absorption after thoracic duct during oesophagectomy

Due to failure to obtain the participants’ consent for dynamically monitoring the absorptive function after operation, it could not be determined the duration of these effects of ligation of thoracic duct, which have more important clinical significance.

**CONCLUSION**

Ligation of the thoracic duct during oesophagectomy affected the D-xylose absorptive function, especially on the first day after operation. The results of this study illustrated that the thoracic duct ligation affects the people’s absorptive function, which is very important for enteral nutrition. So enteral nutrition along with parenteral nutrition have been recommended for the patients whose thoracic duct had been ligated, especially in the early days after operation.

**REFERENCES**


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**Table II: T-test for comparison blood D-xylose concentration before and after operation.**

<table>
<thead>
<tr>
<th>Group (frequency)</th>
<th>Ligation group (n = 30)</th>
<th>No ligation group (n = 30)</th>
<th>t</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before operation</td>
<td>143.06 ±2.92</td>
<td>144.14 ±3.29</td>
<td>1.34</td>
<td>0.1849</td>
</tr>
<tr>
<td>After operation</td>
<td>139.98 ±3.42</td>
<td>142.23 ±2.76</td>
<td>2.82</td>
<td>0.0066</td>
</tr>
</tbody>
</table>

**Figure 1:** D-xylose standard curve was pictured according to different concentration of D-xylose solution and corresponding absorbance.

Transthoracic esophagogastrectomy under the aortic arch by the same group surgeons. Direct ligation of the thoracic duct was performed to improve the precision of experiment.18

The relationship between D-xylose solute concentration and absorbance ability was linear, with the lower limit of quantitation for D-xylose solute concentration was 0.025 mg/ml and the upper limit of quantitation was 0.2 mg/ml. There was significant differences in the blood D-xylose concentration between ligation groups and non-ligation groups. In order to confirm whether those patients were really homogeneous, the blood D-xylose concentration of two groups were tested before the operation, which showed no significant differences between the two groups.

To prevent and treat chylothorax, ligation of the thoracic duct has been successfully used for many years and resulted in unfavourable clinical consequences at the same time.19 Pathological and physiological changes after thoracic duct ligation still need to be examined by further experiments, including lymphostasis, decreased immune function, gastrointestinal malabsorption and so on. So prophylactic thoracic duct ligation is not recommended for patients without obvious damage to the thoracic duct. The gastrointestinal function of patients are often disturbed including emptying delayed, deficiency of digestive enzyme secretion, malabsorption and so on, affected by operation and anesthesia.20 As expected, whether the thoracic duct is ligated or not, the blood D-xylose concentration is lower than that before operation. The absorptive function of ligation group is especially weaker after operation. Thus providing simple enteral nutrition for oesophagectomy patients at early stage after operation is not recommended.


