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Thoracoscopic Versus Subxiphoid Pericardial Window in Patients with End-Stage Renal Disease

Ehab F. Salim¹, MD. Moataz E. Rezk¹, MD.

¹Department of Cardiothoracic Surgery, Faculty of Medicine, Benha University, Egypt.

*Corresponding author: Ehab F. Salim, MD. Department of Cardiothoracic Surgery, Faculty of Medicine, Benha University, Benha, Egypt. Email: ehabfawzii@yahoo.com

Contact details: mobile 00966538029845
Address: KSA, Taif, King Faisal Medical complex

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Ehab F. Salim¹, MD. Moataz E. Rezk¹, MD.

¹Department of Cardiothoracic Surgery, Faculty of Medicine, Benha University, Egypt.

*Corresponding author: Ehab F. Salim, MD. Department of Cardiothoracic Surgery, Faculty of Medicine, Benha University, Benha, Egypt. Email: ehabfawzii@yahoo.com

Abstract

Background: Pericardial effusion is a common problem in patients with end-stage renal disease (ESRD). There are many surgical approaches to perform a pericardial window in those patients. This study compares the safety and efficacy of VATS and subxiphoid approaches in performing a pericardial window for pericardial effusion in patients with ESRD.

Method: From February 2015 to March 2017, a prospective study included a total number of 30 patients of ESRD who were prepared for pericardial window. Patients were randomly divided into two groups: group A (15 patients who underwent VATS pericardial window), and group B (15 patients who underwent subxiphoid pericardial window). Patients were followed-up for 12 months postoperatively.

Results: Both procedures are safe and effective in the management of pericardial effusion. Preoperative data showed no significant difference between both groups. In VATS group, there were significant increased operative times (p-value = 0.031) but with a significantly shorter length of hospital stay (p-value = 0.037) when compared to the subxiphoid group. In both groups, no mortality was recorded. Recurrent pericardial effusion was detected in 5 patients (33.3%) in the subxiphoid group while it was detected in 1 patient (6.7%) in VATS group (p-value =0.169). VATS approach was the independent predictor of freedom from recurrence (hazard ratio: 0.054; p-value = 0.020)

Conclusion: VATS is a safe and effective procedure in the management of pericardial effusion in patients with ESRD. VATS approach decreased total length of hospital stay and decreased the incidence of recurrence of pericardial effusion.

Keywords: VATS; pericardial effusion; pericardial window, renal disease
Introduction

Pericardial effusion is a common problem in patients with end-stage renal disease (ESRD). Pericardial effusion in ESRD could be due to uremic pericarditis or due to dialysis associated pericarditis. Uremic pericarditis is defined as the pericarditis which appears before or within the first eight weeks of starting dialysis. Meanwhile, dialysis-associated pericarditis is defined as the pericarditis that occurs in patients who are on dialysis for more than eight weeks. Moreover, the clinical picture of pericarditis in ESRD patients differs from that of non-ESRD patients [1].

Management of uremic pericarditis includes initiation or intensification of dialysis. Meanwhile, the management of dialysis-associated pericarditis with pericardial effusion has not been studied well, and there is considerable debate about it [1,2]. In patients without any hemodynamic compromise, intensified dialysis is recommended. If there is a hemodynamically significant amount of pericardial effusion, surgical drainage is suggested [2].

However, other investigators do not wait till the development of hemodynamically significant amount of pericardial effusion and recommend early drainage of this pericardial effusion, especially if serial echocardiograms showed the progression of the pericardial effusion to a large effusion or showed a persistence of a large effusion [2].

There are many surgical approaches to perform pericardial drainage in those patients. Pericardiocentesis was used for many years as a pericardial drainage procedure. Nevertheless, the definitive surgical drainage was achieved after making a pericardial window through a left thoracotomy, subxiphoid approach or recently by VATS [1].

A pericardial window allows drainage of pericardial fluid into the adjacent space, usually the pleural cavity. The subxiphoid approach is erroneously referred to as a “window “because no connection is made to the adjacent space during the standard subxiphoid approach. The thoracoscopic approach creates a true window but it is done under general anaesthesia with single-lung ventilation and through 2 or 3 intercostal ports [3]. However, the role of the thoracoscopic approach is limited in patients with hemodynamically significant pericardial
effusions due to the positioning of the patients in the lateral decubitus which makes emergency pericardiocentesis very difficult [4].

Choosing the best surgical approach to drain the pericardial effusion is a matter of debate and it should be based upon the effectiveness of the approach in avoiding recurrence of the pericardial effusion and upon the morbidity and mortality associated with the procedure. Moreover, the relative simplicity of the procedure and its cost are other important aspects that should be considered when choosing the optimal surgical approach [3].

Unfortunately, there is little data in the literature covering the surgical management of pericardial effusion in ESRD patients, and therefore, this study was designed to address this topic. Our goal was to obtain a specific data which could guide the surgeons to choose between both approaches in ESRD patients.

**Patients and methods**

After Ethical Committee approval, a prospective study was designed and included a total number of 30 patients of ESRD who were prepared for the pericardial window from February 2015 to March 2017. All patients had given informed consents. Patients were randomly divided into two groups: group A (15 patients who underwent VATS pericardial window), and group B (15 patients who underwent subxiphoid pericardial window).

Echocardiographical data were collected preoperatively to evaluate the size of the effusion, the presence of adhesions and localized effusion, and the presence of tamponade. Pericardial tamponade was indicated by the presence of right atrial compression or right ventricular diastolic collapse, or both. A pericardial window was indicated when serial echocardiograms show either progression or persistence of large pericardial effusion or show signs of pretamponade or tamponade.

A computed tomography (CT) scan was performed preoperatively to rule out any concomitant pleural or pulmonary pathology and to detect any pericardial adhesions and localised effusions.

All data were recorded to compare the preoperative, operative and postoperative data between both groups. Patients were followed-up for 12 months postoperatively. Recurrence of pericardial effusion was an important outcome which was given a special evaluation and a further statistical analysis. Recurrence of pericardial effusion was defined as the
postoperative effusion detected by echocardiography as moderate or severe effusion which has a hemodynamic significance causing symptoms or causing death.

Operative techniques:

Preoperative evaluation of all patients should be done carefully before sending the patients to the operating room. If there is any hemodynamically significant pericardial effusion, preoperative echocardiography-guided pericardiocentesis is done urgently to stabilize the patient. All patients should be hemodynamically stable before induction of general anaesthesia.

a. VATS pericardial window:

After double lumen intubation under general anaesthesia, patients were positioned in the lateral decubitus position. 2 or 3 incisions of < 10 mm in the left 4th and 6th intercostal spaces were used for insertion of trocars to allow passage of the endoscopic camera and other endoscopic surgical instruments.

The left pleura and left lung were inspected and examined first. Then, pericardiocentesis was done under direct endoscopic visualization and the collected pericardial fluid was sent for microbiological and cytological analysis.

After identification of the left phrenic nerve, a small incision was made with caution in the distended pericardium by electrocautery. Then, the pericardium was grasped with an endoscopic grasper forceps and incised with curved endoscopic scissors. By using the endoscopic suction device, all septae and loculations were broken down till the heart become circumferentially freed from any adhesions.

An area of pericardium of nearly 2cm x 3cm was excised carefully to create a pericardial window after careful protection of the left phrenic nerve. The excised pericardium was sent for histopathological and microbiological examination. One chest tube was introduced through one of the port incisions (Figure 1).

Patients were extubated and then shifted to the recovery room for observation and then returned to their ward on the same day. When the daily drainage of the chest tube was < 100 ml, the chest tube was removed. All cases were provided with postoperative analgesia.
b. Subxiphoid pericardial window:

A short (5 cm long) incision was made over the xiphoid process and extending downwards in the upper part of the midline of the abdomen. The linea alba was incised without opening the peritoneal cavity. The xiphoid process was incised and might be totally removed. The retrosternal space was entered by blunt finger dissection. With upward retraction, the pericardium could be visualized and then grasped or incised directly. The opening made in the pericardium was widened by finger dissection. By using a protected sucker, the pericardial fluid was aspirated. A pericardial biopsy was then taken for histopathological examination. After the complete evacuation of the pericardial effusion, a finger was introduced into the pericardial cavity to exclude the presence of adhesions or loculations. A chest tube was inserted through a separate incision into the pericardial cavity. Finally, the incision was closed in layers.

Figure 1: Steps of VATS pericardial window:
(A): The pericardium is cleared off the pericardial fat. (B): Incision of the pericardium in the area of the left pericardiophrenic recess. (C): Incision is continued cranially in front of the left phrenic nerve. (D): The pericardium is incised anteriorly till creating a 2x3 cm window.
Statistical analysis

SPSS version 22 was used for the statistical analysis of the collected data. Data are mean ± standard deviation or numbers of patients with the percentage in parenthesis. Independent t-test determined significance between the two groups if data are quantitative while chi-square test was used if data are categorical. Furthermore, Fisher's exact test was used instead of chi-square test if there are expected cell frequencies less than 5. A p value of less than 0.05 was considered significant. Time to recurrence was modelled by using Kaplan-Meier curves. Cox proportional hazards models were used to estimate the risk of recurrence.

Results

Regarding demographic data of our study, there were 9 males and 6 females with mean age of 59.51±6.62 years in VATS group, while there were 10 males and 5 females with mean age of 57.73±8.39 years in the subxiphoid group. Mean serum creatinine was 7.52±1.49 in VATS group while mean serum creatinine in the subxiphoid group was 7.86±1.22. In VATS group, there were 10 patients (66.7%) with a positive history of diabetes mellites while, in the subxiphoid group, there were 12 diabetic patients (80%). 3 patients (20%) developed preoperative tamponade in VATS group meanwhile 4 patients (26.7%) developed preoperative tamponade in the subxiphoid group. Regarding age, sex, serum creatinine, history of diabetes mellites and preoperative tamponade, there were no significant differences between both groups. These demographic and preoperative data are summarized in Table 1.

In VATS group, the mean operative time was 58.86±4.62 minutes while it was 34.53±2.74 minutes in the subxiphoid group. Mean operative time was significantly shorter (p = 0.031) in the subxiphoid group. The mean drained effusion volume in VATS group was 532.06±106.92 ml while it was 591.80±154.36 ml in the subxiphoid group (p = 0.162). The mean total blood loss in VATS group was 111.53±12.55 ml while it was 123.73±24.69 ml in the subxiphoid group. Moreover, there was no significant difference in blood loss (p = 0.135) between both groups. In VATS group, the duration of the chest drain was 2.40±0.50 days, and it was 3.34±0.48 days in the subxiphoid group. Regarding the duration of the chest drain, there was no significant difference between both groups (p = 0.478).
In VATS group, arrhythmia (sinus tachycardia and supraventricular tachycardia) were reported in 3 patients (20%). Meanwhile, arrhythmia was noted in 4 patients (26.7%) in the subxiphoid group. Regarding cardiac complications, there was no significant statistical difference between both groups (p = 1.000). In VATS group, postoperative dyspnea (due to postoperative pneumothorax and chest infections) were reported in 2 patients (13.3%). Meanwhile, only 1 patient (6.7%) in the subxiphoid group developed postoperative pneumonia. There was no significant statistical difference between both groups (p = 1.000) regarding respiratory complications. In VATS group, 1 patient (6.7%) developed a mild superficial wound infection. Meanwhile, 2 patients (13.3%) in subxiphoid group developed a mild superficial wound infection. There was no significant statistical difference between both groups (p = 1.000) regarding wound infection. In VATS group, the mean duration of ICU stay was 1.46±0.51 days while it was 2.40±0.50 days in the subxiphoid group. There was no significant difference in the mean duration of ICU stay between both groups (p = 0.526). In VATS group, the mean total length of hospital stay was 8.66±0.48 days while it was 13.33±1.11 days in the subxiphoid group. In VATS group, there was a significantly shorter total length of hospital stay (p = 0.037). No in-hospital mortality was recorded in both groups.

Recurrence of pericardial effusion was detected in 1 patient (6.7%) in VATS group. Meanwhile, recurrence was detected in 5 patients (33.3%) in the subxiphoid group. There was no significant statistical difference between both groups (p = 0.169) regarding the recurrence of pericardial effusion. Intraoperative and postoperative data of both groups were summarized in Table 2.

Cox proportional hazards model was implemented to get the hazard ratio of recurrence of pericardial effusion in both groups. Covariates which were chosen for this model included both procedures (VATS and subxiphoid approaches), serum creatinine, diabetes mellitus, the presence of preoperative pericardial tamponade and volume of this pericardial effusion. The hazard ratio of recurrence of pericardial effusion after VATS was 0.054 when compared to subxiphoid approach. This result had documented a high degree of statistical significance (p = 0.020; 95% confidence interval, 0.05 to 0.632). Meanwhile, other variables (serum creatinine, diabetes mellitus, the presence of preoperative
pericardial tamponade and volume of pericardial effusion) were independently insignificant in the recurrence model. These data were summarized in Table 3.

Kaplan Meier curves of freedom from recurrent effusion were shown in figure 2.

![Kaplan Meier curves of freedom from recurrent effusion](image)

**Figure 2**: Kaplan Meier curves of freedom from recurrent effusion.

**Discussion**

Pericardial effusion in patients with end stage renal disease (ESRD) has been approved to have a decreased response to solute clearance with dialysis or even intensification of the set of dialysis. Moreover, those patients are more symptomatic than other patients with pericardial effusion due to other causes and are more prone to develop sanguineous or haemorrhagic effusion. Furthermore, those patients are more susceptible to develop tamponade and haemodynamic instability [1].

Pericardiocentesis was used for successful decompression of massive pericardial effusion and tamponade in ESRD patients. Nevertheless, pericardiocentesis was associated with increased
morbidity and mortality due to development of acute tamponade, hypotension, arrhythmia, myocardial lacerations, cardiac arrest and death. Moreover, inadequate drainage or recurrence was frequently reported with pericardiocentesis [2]. Therefore, pericardiocentesis was abandoned in most health care centres as it was not considered to be a definitive management for pericardial effusions [5].

Partial and total pericardiectomy are used due to their low recurrence rate. However, they are done through a left thoracotomy or a median sternotomy approaches which increased the morbidity and mortality associated with those approaches. The subxiphoid approach had overcome these disadvantages because it is much less invasive and effectively drains the pericardial cavity. Moreover, this approach could be done under local anaesthesia and hence avoiding the possible risk associated with the general anaesthesia in those critically ill patients. Therefore, the subxiphoid approach had become the most appropriate approach for long times till the implementation of VATS [3].

Therefore, we reviewed our experience with VATS and subxiphoid approaches for a pericardial window in ESRD patients to compare between the two approaches and to find a clear difference between them to help the surgeons who are trying to choose between the two approaches.

Although ESRD is a relatively common problem, few of them develop pericardial effusion that requires surgical drainage. Therefore, most of the studies discussing the surgical management of ESRD patients with pericardial effusion are small series and this could explain the relatively small number of patients in this study.

In this series, there was no significant difference between both groups regarding preoperative data. In both groups, general anaesthesia was well-tolerated. Moreover, single lung ventilation was well-tolerated in the VATS group. Preoperative pericardiocentesis was routinely performed in patients with tamponade under echocardiographic guidance to relieve the tamponade effects in the hemodynamically unstable patients before induction of anaesthesia.
VATS pericardial window provided more effective pericardial resection than the subxiphoid approach [6]. Furthermore, VATS approach provided better visualisation and better management of adhesions and loculated effusions than the subxiphoid approach [7].

In our study, the mean operative time (skin to skin time) was longer in VATS group (58.86±4.62 minutes) than the subxiphoid group (34.53±2.74 minutes). This mean operative time coincided with that of other series which ranged between 27 and 57 minutes [8,9]. Meanwhile, this mean operative time was much shorter than other series in which the mean operative time was 75.2±25.4 minutes in the subxiphoid group and 111.3±30.7 minutes in VATS group [7]. This could be explained by calculating the anaesthesia time as the operative time in their study and so more time will be included to provide the time needed to (a) insert a double-lumen endotracheal tube and (b) to position the patient in the lateral decubitus position.

This study was specifically dealing with ESRD patients who had additional comorbidity due to their renal disease than other series dealing with pericardial effusion due to other causes. This could explain the increased incidence of complication in our study when compared to other series which reported the absence of any postoperative complications [7].

In our study, the mean duration of the total length of hospital stay in VATS group was 8.66±0.48 days while it was 13.33±1.11 days in the subxiphoid group. There was a significantly shorter total length of hospital stay (p = 0.037) in VATS group. This result did not match with the results obtained by O’Brien et al., who reported a length of hospital stay of 12.4 ±22.8 days in VATS group and 10.4 ±12.2 days in the subxiphoid group (p = 0.640) [3].

No Pericardial decompression syndrome was noted in our study. Pericardial decompression syndrome is a potentially fatal and a rare complication that develops within the first 48 hours postoperatively after pericardial drainage, either by pericardiocentesis or by surgical drainage. It manifests with hemodynamic deterioration and pulmonary oedema due to ventricular dysfunction [10].
In our study, no in-hospital mortality was recorded. This result coincides with the data reported by a previous study [7]. However, postoperative mortality was recorded in both groups due to causes not related to our surgical intervention. 1 patient in VATS group died due to polytrauma as a result of road traffic accident in the 8th month postoperatively, and one patient in the subxiphoid group died in the 10th month postoperatively due to complications of pneumonia.

Recurrence of pericardial effusion was noted 1 patient (6.7%) in VATS group and 5 patients (33.3%) in the subxiphoid group. Although the crude recurrence rate was not significantly different between both groups (p = 0.169), Cox proportional hazards model had determined that VATS approach had conferred a statistically significant decrease in the risk of recurrence of pericardial effusion (hazard ratio = 0.054). This result could be expected due to the creation of a true pericardial window into the pleural space which would decrease the recurrence rate in the VATS group. This result matched with the results obtained by other series [3].

Postoperative pain was not assessed in this study. However, it is expected that the small midline incision in the subxiphoid group is less painful than the 2 to 3 intercostal incisions used for VATS. Surely, the upper abdominal midline incision has no risk of developing the prolonged intercostal neuralgia which could complicate any VATS procedures [11,12].

Finally, many recent studies [13-17] had confirmed the efficacy and safety of VATS pericardial window in the management of pericardial effusion. However, it should be noted that VATS approach should be used with many precautions (a) in patients with tamponade and hemodynamic instability and (b) in those patients with impaired respiratory functions who could not tolerate single lung ventilation or the lateral operative position. Moreover, the subxiphoid approach should be the preferred approach (a) in patients whose life expectancy is more likely to be extremely short due to associated major co-morbidities or associated extensive metastasis or (b) in patients with hemodynamic instability because it is simpler and faster than the thoracoscopic approach.

**Disclosure**

The authors have no conflict of interest to declare.
Acknowledgement

None.

References


Table 1: Comparison of patients’ characteristics between both groups.

<table>
<thead>
<tr>
<th></th>
<th>VATS group</th>
<th>Subxiphoid group</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Age</td>
<td>59.51±6.62</td>
<td>57.73±8.39</td>
<td>0.133</td>
</tr>
<tr>
<td>- Male</td>
<td>9 (60%)</td>
<td>10 (66.7%)</td>
<td>1.000†</td>
</tr>
<tr>
<td>- Female</td>
<td>6 (40%)</td>
<td>5 (33.4%)</td>
<td>1.000†</td>
</tr>
<tr>
<td>- Serum creatinine</td>
<td>7.52±1.49</td>
<td>7.86±1.22</td>
<td>0.158</td>
</tr>
<tr>
<td>- Diabetes mellitus</td>
<td>10 (66.7%)</td>
<td>12 (80%)</td>
<td>0.682†</td>
</tr>
<tr>
<td>- Tamponade</td>
<td>3 (20%)</td>
<td>4 (26.7%)</td>
<td>1.000†</td>
</tr>
</tbody>
</table>

*: Fisher’s exact test was used when there are expected cell frequencies less than 5.

Data are mean ± standard deviation or numbers of patients (with the percentage in parenthesis).

Table 2: Comparison of operative and postoperative data between both groups.

<table>
<thead>
<tr>
<th></th>
<th>VATS group</th>
<th>Subxiphoid group</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Operative time in minutes</td>
<td>58.86±4.62</td>
<td>34.53±2.74</td>
<td>0.031</td>
</tr>
<tr>
<td>- Drained effusion volume in ml</td>
<td>532.06±106.92</td>
<td>591.80±154.36</td>
<td>0.162</td>
</tr>
<tr>
<td>- Total blood loss in ml</td>
<td>111.53±12.55</td>
<td>123.73±24.69</td>
<td>0.135</td>
</tr>
<tr>
<td>- Chest drain duration in days</td>
<td>2.40±0.50</td>
<td>3.34±0.48</td>
<td>0.478</td>
</tr>
<tr>
<td>- Cardiac complications</td>
<td>3 (20%)</td>
<td>4 (26.7%)</td>
<td>1.000†</td>
</tr>
<tr>
<td>- Respiratory complications</td>
<td>2 (13.3%)</td>
<td>1 (6.7%)</td>
<td>1.000†</td>
</tr>
<tr>
<td>- Superficial wound infection</td>
<td>1 (6.7%)</td>
<td>2 (13.3%)</td>
<td>1.000†</td>
</tr>
<tr>
<td>- ICU stay in days</td>
<td>1.46±0.51</td>
<td>2.40±0.50</td>
<td>0.526</td>
</tr>
<tr>
<td>- The total length of hospital stay</td>
<td>8.66±0.48</td>
<td>13.33±1.11</td>
<td>0.037</td>
</tr>
<tr>
<td>- In-hospital mortality</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
<td>-</td>
</tr>
<tr>
<td>- Recurrence of pericardial effusion</td>
<td>1 (6.7%)</td>
<td>5 (33.3%)</td>
<td>0.169†</td>
</tr>
</tbody>
</table>

*: Fisher’s exact test was used when there are expected cell frequencies less than 5.

Data are mean ± standard deviation or numbers of patients (with the percentage in parenthesis).
Table 3: Cox proportional hazards model of risk of recurrent pericardial effusion after surgical drainage

<table>
<thead>
<tr>
<th></th>
<th>Hazard ratio</th>
<th>95% CI for hazard</th>
<th>P value</th>
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<tr>
<td></td>
<td></td>
<td>Lower</td>
<td>Upper</td>
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<tr>
<td>VATS</td>
<td>0.054</td>
<td>0.005</td>
<td>0.632</td>
</tr>
<tr>
<td>Serum creatinine</td>
<td>0.448</td>
<td>0.196</td>
<td>1.023</td>
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<tr>
<td>Diabetes mellitus</td>
<td>0.176</td>
<td>0.118</td>
<td>0.694</td>
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<tr>
<td>Tamponade</td>
<td>0.461</td>
<td>0.017</td>
<td>12.611</td>
</tr>
<tr>
<td>Volume of pericardial effusion</td>
<td>0.490</td>
<td>0.479</td>
<td>1.002</td>
</tr>
</tbody>
</table>

CI: Confidence Interval

^a^: p value < 0.05