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Recommendations for Overcoming Difficulties in Video Assisted Thoracoscopic Pericardial Fenestration

Video Yardımlı Torakoskopik Perikardiyal Pencere Uygulamasında Karşılaşılan Zorluklar için Öneriler

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ÖZ

Amaç: Perikardiyal pencere, tekrarlayan perikardiyal efüzyonu tedavi etmek için kullanılır. Bu çalışmada, günümüzde daha çok öne çıkan video yardımlı torakoskopik cerrahi (VATS) kullanılarak perikardiyo-plevral pencere (PPF) uygulamalarında yaşanan sorunların ve çözüm önerilerinin değerlendirilmesi amaçlanmıştır.
Araçlar ve Yöntem: Temmuz 2018 - Aralık 2020 tarihleri arasında Ondokuz Mayıs Üniversitesi Tıp Fakültesi'nde VATS PPF uygulanan toplam 8 hasta (3 erkek, 5 kadın; ortanca yaş: 51.8 yıl, aralık: 23-65 yıl), retrospektif olarak değerlendirildi ve bulgular literatürde bildirilen sonuçlarla karşılaştırıldı.
Bulgular: Ekokardiyografide inferior duvara komşu ölçülen sıvı ile boşaltılan perikardiyal sıvı miktarı arasında istatistiksel olarak anlamlı pozitif korelasyon vardı (p=.032). Daha kısa cerrahi süre, sağ lateral 45° pozisyon ve tek port müdahaleleri ile korele idi (p= .020). Göğüs tüpünün ortalama çıkarılma süresi 3,1 gün (min: 2,0-maks: 7,0) ve ortalama taburcu olma süresi 6,1 gündü (min: 3,0-maks: 10,0).
Sonuç: Sağ lateral 45° pozisyonda tek port ile 4. interkostal aralıktan gerçekleştirilen VATS PPF, tedavi şekline rağmen tekrarlayan perikardiyal efüzyonu olan hastalarda güvenle kullanılabilecek cerrahi tedavi yöntemidir.

Anahtar Kelimeler: perikardiyal efüzyon; perikardiyal fenestrasyon; VATS

ABSTRACT

Purpose: Pericardial fenestration is used to treat recurrent pericardial effusion. This study aimed to assess the issues and solutions in pericardio-pleural fenestration (PPF) applications using video-assisted thoracoscopic surgery (VATS), which is more prominent today.
Materials and Methods: Between July 2018 and December 2020, a total of 8 patients (3 males, 5 females; median age: 51.8 years, range: 23–65 years), who underwent VATS PPF in the Ondokuz Mayıs University Faculty of Medicine, were retrospectively evaluated using the hospital database and the findings were compared with the results reported in previous literature.
Results: The amount of pericardial fluid drained and the measurement of fluid next to the inferior wall on echocardiography had a statistically significant positive and high correlation (*p*=.032). Shorter surgical time was correlated with the right lateral 45° position and single port interventions (*p*=.020). The average time to remove the chest tube was 3.1 days (min: 2.0-max: 7.0), and the average time to discharge was 6.1 days (min: 3.0-max: 10.0).
Conclusion: VATS PPF conducted through the 4th intercostal space with a single port in the right lateral 45° position is a procedure that can be safely used in patients with recurrent pericardial effusion, despite the type of therapy.

Keywords: pericardial effusion; pericardial fenestration; VATS

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INTRODUCTION

A pericardial effusion (PE) can develop secondary to benign and malignant pathologies. Pericardiocentesis may be indicated for diagnostic or therapeutic reasons, or both.[1] Pericardiocentesis is used for therapeutic objectives, particularly in the case of cardiac tamponade, and cytological assessment can also be conducted. In malignant pathologies, when drainage of the haemorrhagic fluid is inadequate, and when benign fluid or localised effusions recur, they are treated surgically with pericardial fenestration.[2]

Pericardial fenestration can be done in a variety of ways, including the subxiphoid and transthoracic approaches. In the past of 20 years, minimally-invasive surgical methods have gained prominence. By generating a large window and analysing it in presence of concurrent pleural pathologies, video-assisted thoracoscopic surgery (VATS) has made the approach more advantageous.[3] However, despite its advantages, VATS pericardio-pleural fenestration (PPF) can cause complications. The goal of our research was to assess the issues and identify solutions in our VATS PPF applications.

MATERIALS and METHODS

VATS has been performed in our centre since 2000. Between July 2018 and December 2020, a total of 8 patients (3 males, 5 females; median age: 51.8 years, range: 23–65 years), who underwent VATS PPF in the Ondokuz Mayıs Faculty of Medicine, Cardiovascular and Thoracic Surgery Clinics, were retrospectively evaluated using the hospital database and the findings were compared with the results reported in previous literature. Written informed consent was obtained from each patient, or legal guardian of the patient, if the patient was unable to provide consent. The study protocol was approved by the Ondokuz Mayıs University Clinical Research Ethics Committee (Date: 11.03.2021 and approval no: OMÜKAEK:2021/125). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Selection

The study involved adult patients who had a PE diagnosis and had undergone VATS PPF treatment. Electrocardiogram, chest X-ray, blood values, echocardiography (ECHO) and computed thorax tomography were performed during the preoperative patient assessments. The study excluded patients who had pericardial catheterization and an open pericardial window due to recurrent PE.

Surgical Method

Under general anaesthesia, haemodynamically stable patients were intubated with a double-lumen intubation tube for one-lung ventilation. Central venous and arterial catheterization was performed. Patients were operated on in the right lateral decubitus (RLD) or right lateral 45° (RL45) position (Figure 1). All patients were operated on from the left side (Figure 2). The left hemithorax was explored by imaging with a thoracoscope (HOPKINS® Forward-Oblique 30° Telescope, Karl Storz, Tuttlingen, Germany). A needle was used to aspirate fluid from the left hilus level anterior to the phrenic nerve. Pericardial fluid was aspirated after aspiration by making an incision on the pericardium with endo-scissors. By expanding the incision towards the diaphragm with a bipolar tissue sealing device (LigaSure™-Covidien, Dublin, Ireland) or electro-cautery, a 3x3 cm area on the pericardium was formed. The procedure was terminated by the insertion of a chest drainage tube in the left hemithorax. In the intensive care unit, the patients were extubated by weaning them from the ventilator. The tube with less than 100 ml of fluid was removed after a 24-hour drainage follow-up. Following postoperative ECHO and chest X-ray assessment, the patients were discharged. The patients' age and gender, aetiology, surgical position, thoracoscopy incisions, complications, operation duration and postoperative follow-up were all assessed.

Figure 1. RL45 surgical position

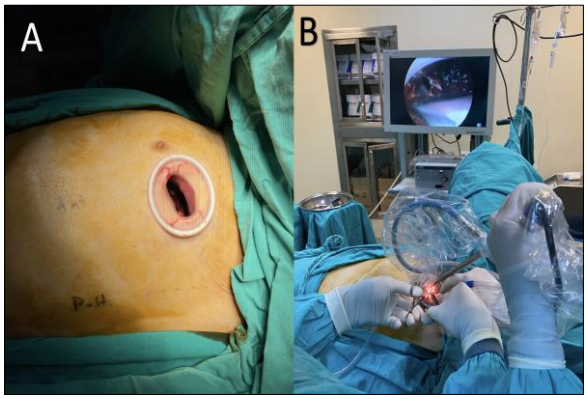

Figure 2. Uniportal VATS PPF applied to the patients from the left hemithorax (A) Uniport access, (B) Use of camera and surgical instruments from the Uniport access.

Statistical Analysis

Data were analysed with IBM SPSS for Windows Version 23.0 Software (IBM Corp., Armonk, NY, USA). The Shapiro-Wilk test was used to assess conformity to the normal distribution. The independent two-sample t-test was used to compare the normally distributed surgery time by position. The Pearson correlation coefficient was used to evaluate the correlation between the normally distributed data; the Spearman's rho correlation coefficient was used to evaluate the correlation between the non-normally distributed data. The Wilcoxon test was used to compare the non-normally distributed ejection fraction values preoperatively and postoperatively. The continuous variables were presented in mean ± standard deviation (SD), median (min-max). The categorical variables were expressed in number and percentage. The level of significance was taken as $p<.050$.

RESULTS

Frequency distribution of the categorical variables and descriptive statistics of the quantitative data are summarised in Table 1 and 2.

The amount of discharged pericardial fluid and the measurement of fluid adjacent to the ECHO inferior wall had a statistically significant positive and high correlation (r= 0.749; $p=.032$). The amount of discharged pericardial fluid had no statistically significant relationship with the other variables ($p>.050$) (Table 3). There was no statistically significant difference between the EF, as measured by the preoperative ECHO ($p=.661$), the amount of pericardial fluid drained and the EF, as measured by the postoperative ECHO ($p=.210$).

Table 1. Frequency distribution of the categorical variables

Variables	Frequency (n)	Percent (%)
Sex		
Male	3	37.5
Female	5	62.5
Symptom		
Dyspnea	6	75
Flutter	2	25
Position		
Right Lateral Decubit (RLD)	3	37.5
Right Lateral 45° (RL45)	5	62.5
Pathology		
Chronic Pericarditis	5	62.5
Hyalinized Fibrous Tissue	2	25
Other	1	12.5

Table 2. Descriptive statistics of the quantitative data

Variables	Mean ± SD	Median [Min - Max]
Age (year)	51.8 ± 12.8	56.5 [23.0 - 65.0]
EF measured by preoperative ECHO (%)	53.1 ± 3.7	52.5 [50.0 - 60.0]
Fluid measurement adjacent to the ECHO lateral wall (mm)	26.8 ± 10.1	25.0 [15.0 - 47.0]
Fluid measurement adjacent to the ECHO inferior wall (mm)	32.9 ± 10.6	35.0 [12.0 - 46.0]
Fluid measurement adjacent to the ECHO posterior wall (mm)	14.3 ± 7.0	13.0 [6.0 - 23.0]
ECHO left ventricular adjacent fluid measurement (mm)	27.8 ± 6.5	27.0 [20.0 - 36.0]
ECHO right ventricular adjacent fluid measurement (mm)	13.8 ± 4.7	15.5 [6.0 - 21.0]
Blood serum total protein level (gr/dL)	6.2 ± 0.7	6.0 [5.2 - 7.1]
Albumin level of blood serum (gr/dL)	3.5 ± 0.6	3.6 [2.5 - 4.1]
The amount of pericardial fluid drained (cc)	812.5 ± 344.1	800.0 [400.0 - 1400.0]
Total anesthesia time (min)	98.1 ± 32.7	90.0 [60.0 - 160.0]
EF as measured by postoperative ECHO (%)	58.1 ± 3.7	60.0 [50.0 - 60.0]
Chest tube removal (day)	3.1 ± 1.6	3.0 [2.0 - 7.0]
Discharge time (day)	6.1 ± 2.5	5.0 [3.0 - 10.0]

Table 3. Evaluation of the relationship between the amount of discharged pericardial fluid and the fluid measurement values

Variables	The amount of pericardial fluid drained	
	r	p
Fluid measurement adjacent to the ECHO lateral wall	-0.020	0.963
Fluid measurement adjacent to the ECHO inferior wall	0.749	0.032
Fluid measurement adjacent to the ECHO posterior wall	-0.375	0.360
ECHO left ventricular adjacent fluid measurement	-0.036	0.932
ECHO left ventricular adjacent fluid measurement	-0.339	0.411

r: Pearson correlation coefficient

The average surgical time varied depending on the patient's position (RLD or RL45) (p=.008). The RLD position took an average of 131.7 minutes, whereas the RL45 position took an average of 78.0 minutes (Table 4). A statistically significant positive and high correlation was found between the number of ports and the length of surgery (r=0.788; p=.020). There was no statistically significant relationship between the other variables (p>.050) (Table 5). There was no statistically significant difference between the preoperative and postoperative EF values (p= .062).

Table 4. Comparison of surgical time by position

Position	Mean ± SD	Median (min. – max.)	Test statistic	p
Right Lateral Decubit (RLD)	131.7 ± 24.7	120.0 (115.0 – 160.0)	t=3.931	0.008
Right Lateral 45 (RL45)	78.0 ± 14.8	80.0 (60.0 – 100.0)		

t: Independent two-sample t-test statistic

Table 5. Evaluation of the relationship between the number of ports, surgery time, chest tube removal time and discharge times

Variables		Number of ports	Surgical time	Chest tube removal
Surgical time	r	0.788		
	p	0.020		
Chest tube removal	r	-0.008	-0.112	
	p	0.986	0.793	
Discharge time	r	0.317	0.385	0.357
	p	0.444	0.346	0.386

r: Spearman's rho correlation coefficient

DISCUSSION

In the 1990s, VATS was introduced as an alternate approach for PE drainage.[4] Although VATS was initially used solely for diagnostic purposes, it is now widely used for PE treatment.[3]

Various aetiological causes are found in the literature, the most common of which are cardiac surgery, malignancy and idiopathic causes. In their investigation, Sagrista-Sauleda et al. detected acute idiopathic PE in 20% of cases, iatrogenic effusions in 16% of cases and malignancy-related effusion in 13% of cases.[5] It was found that 62.5% of the patients in our study had chronic pericarditis in their aetiology.

Although opinions differ on the position of the patient, Fernandez et al.[6] preferred the lateral decubitus position in their study of 16 patients and Dogusoy et al.[7] preferred the position in which the patient was turned laterally at an angle of 45° in 44 disease groups in which they performed a pericardial window with VATS. In the present study, patients could not tolerate one-lung ventilation, especially due to limited heart function; hence, the RLD location was preferred in 37.5% of our VATS pericardial window applications. Patients with PE frequently cannot tolerate general anaesthesia with one-lung ventilation, according to Ohuchi et al.[8] Therefore, 62.5% of patients underwent VATS in the RL45 position. Furthermore, in our study, a positive correlation was found between the RL45 position and the total anaesthesia time (p=.008).

Regarding access to the pericardium in VATS procedures, Dogusoy et al.[7] preferred the 2-port approach and the 5th intercostal space; Mouton et al.[1] stated that the 3-port approach should be used and the first incision should be made through the 6th intercostal space. In our study, multiple port attempts were used in the 37.5% of the cases. When the port was inserted through the 6th intercostal gap, the proximity of the pericardium to the chest wall constituted a significant disadvantage. The area where the pericardial fenestration would be generated was exhibited with much better visualisation in cases where the intercostal space was determined as the anterior axillary line 4th intercostal space (Figure 3). Furthermore, in our study, a positive correlation was found between the number of ports and the total anaesthesia time. The speed of conversion to open thoracotomy is another advantage of using the Uniportal approach. To convert a Uniportal incision into a thoracotomy, it is sufficient to enlarge the incision posteriorly and insert a thoracic retractor.[9]

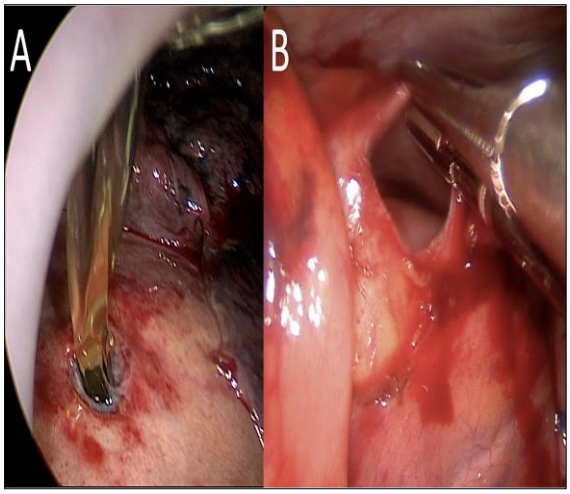

Figure 3. Fenestration opened on the pericardium (A) High flow drainage of PE from the first perforation area on the pericardium; (B) Fenestration area opened on the pericardium.

To the best of our knowledge, there are few studies in the literature comparing the amount of pericardial fluid measured by preoperative ECHO with the amount of fluid drained intraoperatively. Unlike our study, Caspari et al. compared the measurements made with ECHO with the amount of fluid drained during pericardiocentesis performed with ECHO.[10] In our study, a statistically significant correlation was found between the amount of drained pericardial fluid and the measurement of the fluid near the inferior wall.

In pericardial windows performed with VATS, the decision to switch to thoracotomy due to complications is very important. Especially in malignant PEs, the differential diagnosis of myocardial injury should be made if the draining fluid is haemorrhagic in colour. In this type of case, when in doubt, abort the VATS PPF and complete the procedure with a thoracotomy. Conversion to open surgery should never be viewed as a failure of VATS; rather, it should be viewed as a means of ensuring patient safety and avoiding an unanticipated resection.[9] In our study, after draining the haemorrhagic fluid, an anterior thoracotomy was performed in one patient with the suspicion of cardiac injury. Moreover, the existence of pleural adhesions is a relative indication that VATS should be terminated. Pleural adhesions are accepted as an indication for thoracotomy in terms of prolonging the anaesthesia and operative times, but postoperative pain is greater, wound infections are more common and hospital stay is longer in patients who have undergone thoracotomy.

Fibla et al. found that the average length of drainage in patients with a pericardial window opening with VATS was 3.5 days.[11] This duration was 5.3 days in a study by Dogusoy et al.[7] In our study, the average amount of time it took to remove the chest tube was 3.1 days, and the patients were discharged after 6.1 days.

In their series of patients who underwent a pericardial window due to massive PE, Bary et al. encountered intraoperative and postoperative complications, such as bleeding (9%), cardiac injury (13%), air leak due to lung injury (11%), atelectasis (9%) and the recurrence of PE (5.6%).[12] They did not report any intraoperative mortality, but their 30-day mortality rate was 11.[12] In the cases in our study, only one thoracotomy was conducted due to suspicion of bleeding, although thoracotomy confirmed the presence of haemorrhagic fluid. There was no morbidity or mortality.

Nonetheless, our study has some limitations. The small sample size and retrospective design of the study were the main limitations. In addition, the study was conducted using data from a single-centre. Therefore, further large-scale, multi-centre, prospective studies are required to confirm these findings.

In conclusion, the VATS PPF application is a safe method for PE patients. Pericardial fluid should be measured with the preoperative ECHO, and the quality of the fluid should be assessed. The pericardial window procedure can be conducted easily using Uniport VATS in one-lung ventilation and the RL45 position.

Conflict of Interest

The authors declare no conflicts of interest with respect to the authorship and/or publication of this article.

Ethics Committee Permission

The study protocol was approved by the Ondokuz Mayıs University Clinical Research Ethics Committee (Date: 11.03.2021 and approval no: OMÜKAEK:2021/125).

Authors' Contributions

Concept/Design: SG, SBD. Data Collection and/or Processing: SG, NGT. Data analysis and interpretation: SG,

SBD. Literature Search: SG, SBD, NGT. Drafting manuscript: SG, SBD. Critical revision of manuscript: SG, SBD. Supervision: SBD.

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