Original Article

Awake uniportal video-assisted thoracoscopic surgery for the management of pericardial effusion

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Abstract

Introduction: Pericardial drainage can be performed either with pericardiocentesis or pericardial "window" in cases with hemodynamic compromise for therapeutic and diagnostic purposes. Awake single-port video-assisted thoracoscopic surgery (VATS) is an alternative to pericardial window (PW) that has been described only in case reports in the literature. We aimed to analyse a series of patients with chronic, recurrent and/or large pericardial effusions who underwent single-port VATS-PW opening without intubation.

Patients and Methods: The PW was opened using awake single-port VATS in 20 of 23 patients referred to our clinic with recurrent, chronic and/or large pericardial effusion between December 2021 and July 2022. Demographic data, imaging modalities, treatment processes and pathological samples were analysed retrospectively.

Results: The median age of 20 patients was 68 years (52–81). The mean body mass index was 29.1 ± 6.0 kg/m^2 and mean pericardial fluid measurements with pre-operative transthoracic echocardiography (TTE) was 2,8 ± 0,9 cm. The mean operation time was 44 ± 13.0 min and mean peri-operative drainage was 700 ± 307 cc. On the 1st post-operative day, control TTE revealed ≤0.5 cm effusion in 18 (90%) patients and ≥0.5 cm in 2 (10%) patients. The median day of discharge or referral to the clinic where they are followed up was 1 (1–2).

Conclusions: Awake single-port VATS could be used safely in all patient groups with pericardial effusion or tamponade as a diagnostic and therapeutic option. This technique has advantages, especially in patients with high surgical risk.

Keywords: Awake, pericardial effusion, uniportal, video-assisted thoracoscopic surgery

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INTRODUCTION

The pericardial cavity typically contains about 50 ml of fluid. Accumulation of fluid in the pericardium is defined as pericardial effusion. Any pathologies that cause increased production or impaired fluid absorption in the pericardium will end up with pericardial effusion. It is a clinical condition

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with various manifestations, ranging from asymptomatic cases to life-threatening cardiac tamponade.[1] It is considered chronic if the effusion persists for more than 3 months.

Transthoracic echocardiography (TTE) is the first-line imaging test; effusions with an end-diastolic diameter of <10 mm are classified as mild, between 10 mm and 20 mm as moderate and >20 mm as large.[2]

Medical therapy should be ordered in patients without haemodynamic compromise by targeting the underlying disorder. Pericardial drainage, either with pericardiocentesis or pericardial ‘window’ is indicated in cases with a haemodynamic compromise for therapeutic and diagnostic purposes.[3] Pericardial window (PW) is a surgical procedure that removes a portion of the pericardium so that the effusion can drain continuously to the thoracic cavity. In this way, the mass effect (cardiac tamponade) caused by recurrent pericardial effusion (usually malignant) is prevented. This offers a definitive treatment by limiting the recurrence of pericardial effusion.[3] PW is usually performed through video-assisted thoracoscopic surgery (VATS) under general anaesthesia. General anaesthesia itself may complicate and add risk to already high-risk patient groups.[4] In the literature, there are case reports on PW opening with non-intubated single-port VATS.[5,6] Our study aims to analyse a series of patients with chronic recurrent and/or large pericardial effusions and who underwent single-port VATS-PW opening without intubation.

PATIENTS AND METHODS

This single-centre study was conducted in Kartal Koşuyolu Training and Research Hospital, Department of Thoracic Surgery.

Between December 2021 and July 2022, 23 patients were referred to our clinic with recurrent, chronic and/or large pericardial effusions. After approval by the local ethics committee (decision number: 2022/10/582), the patient’s records were evaluated retrospectively. Twenty of 23 patients who were operated on using awake single-port VATS for PW were enrolled in the study. Three emergent patients with general anaesthesia due to haemodynamic instability were excluded from the analysis. Procedures were performed by a single thoracic surgeon.

All patients were analysed for gender, age, body mass index (BMI), pre-operative TTE, co-morbidity, symptom, operation side, operation time, peri-operative drainage, post-operative TTE, discharge time, complications and pathologic specimens.

Pre-operative thoracic computed tomography was used to determine other chest pathologies, and more importantly, the operating side. The place and amount of pericardial effusion within the pericardial sac determined by pre-operative TTE were used to choose the level of an intercostal incision. Based on those views, mid-axillary lines 4, 5 or 6 intercostal spaces were preferred.

Anaesthetic technique

All of the non-intubated 20 patients received 4–6 L/min oxygen supply by a nasal cannula or a face mask during the operation. The vital signs were monitored, and a peripheral intravenous (iv) line was inserted. Radial artery cannulation was used for monitoring continuous invasive blood pressure and analysing arterial blood gas samples. Before the first surgical incision, mild sedation was induced with midazolam 0.1–0.4 mg/kg, fentanyl 1–2 mcg/kg iv bolus, and propofol 1–2 mg/kg over 1–2 min intravenously.

Maintenance of mild sedation was achieved with an intermittent bolus of 20–30 mg propofol. The anaesthesiologist was in charge of the amount and timing of the bolus. If there were signs of inadequate sedation such as low Ramsay Scale, increasing heart rate, respiratory rate, blood pressure, making sounds and movements, an intermittent bolus of propofol was added.

Surgical technique

The patients were placed in the supine position, and the operation side was elevated to 30 degrees. For women, we pull the breast to the other side and fix it with an elastic fixation tape. Before starting the procedure, local anaesthesia with 2% lidocaine was applied to the incision area. A 2.5 cm incision was performed from the mid-axillary line at the junction of the pre-determined intercostal space. Access to the chest cavity was achieved by using electrocautery. A 10 mm 30° video thoracoscope was inserted through the trocar. The trocar was retracted. If the patient also had a pleural effusion, it was drained before pericardial effusion. After identifying and protecting the phrenic nerve, pericardial effusion was evacuated by performing pericardiotomy on the surface of the pericardium with an L hook cautery. Samples were taken from the effusion for cytological and microbiological examination. The pericardium, whose tension was reduced, was grasped with an endo-grasper. The pericardiotomy incision was widened with a 5-mm surgical energy device, and a biopsy was taken by opening a window of approximately 4 cm square from the detected pathological areas. Then, the pleural space, lung parenchyma and mediastinum were evaluated. Following the bleeding control, a 24F chest drain was inserted through the trocar incision into the thoracic cavity and connected to an underwater sealed drain.

The patients were taken to the ward after being observed in the recovery room for approximately 1 h after surgery. A chest X-ray was taken on the 1st post-operative day, and TTE was performed. The drain of the patients without air leakage was terminated, regardless of the amount of drainage.

Patients with additional clinical situations were referred to their relevant clinics for follow-up. Other patients were discharged for outpatient control after 10 days.

Statistical analysis

The software IBM® SPSS® (Statistical Package for the Social Sciences) version 22 (IBM Corp. Armonk, NY, USA) was used for the statistical analysis. Qualitative data were presented as frequency and percentage. The patient's age, drain removal time, post-operative TTE and discharge time showed non-normal distribution according to the Shapiro–Wilk test and were given as median interquartile range. BMI, pre-operative TTE, operation time and perioperative drainage were presented as the mean ± standard deviation with a normal distribution.

RESULTS

All patients' pre-, intra- and post-operative data are detailed in Table 1 and the mean and median values are given in Table 2.

Of the 20 patients, 12 (60%) were males, 8 (40%) were females, and the median age was 68 years (52–81). The left side was preferred for 15 patients (75%) and the right for 5 (25%). The mean BMI was 29.1 ± 6.0 kg/m² and mean pericardial fluid measurements in the largest region with pre-operative TTE were 2.8 cm ± 0.9 cm. Co-morbidity was present in 17 (85%) patients. Five (25%) patients had concurrent pleural effusion. All patients presented with dyspnoea. One patient had a fever in addition to this symptom.

The mean operation time was 44 ± 13.0 min and mean peri-operative drainage was 700 ± 307 cc.

On the 1st post-operative day, control TTE revealed ≤0.5 cm effusion in 18 (90%) patients and ≥0.5 cm in 2 (10%) patients. The median pericardial fluid observed in post-operative TTE was 0.1 cm (0–0.5). The median drain removal time was 1 day (1–1). The median day of discharge and/or referral to the clinic where they are followed up due to comorbidities was 1 (1–2). One patient with several comorbidities such as hypertension, chronic renal failure, chronic obstructive lung disease and atrial fibrillation died on the 5th post-operative day and another patient with similar comorbidities died on the 6th post-operative day. Both were not attributed to pericardial procedure.

There was no microbial growth in all patients' microbiological tests of culture samples. Histopathological diagnoses were reported as chronic non-specific inflammation 11 (55%), acute chronic non-specific inflammation 4 (20%), hyalinisation 4 (20%) and chronic lymphocytic leukaemia infiltration 1 (5%). Biopsy from the enlarged mediastinal lymph node of a patient whose pericardial biopsy was not malignant was reported as carcinoma metastasis. Pericardial fluids were checked by performing TTE on the wound site on the 10th post-operative day. Pericardial fluid accumulation and any post-operative complications were not observed.

DISCUSSION

The surgical approach remains the gold standard for pericardial drainage and biopsy.[1]

PW is a surgical procedure that allows long-term drainage by performing pericardial resection to provide a passage between the pericardial space and the pleural cavity. The optimal surgical technique for the drainage of pericardial effusions is frequently debated. Subxiphoid and thoracotomy approaches are commonly used techniques in PW surgery. Mack *et al*. defined VATS pericardiectomy as an alternative to lateral thoracotomy and subxiphoid PW in the early 90s.[7]

VATS has become a commonly used surgical technique for PW opening over the years.[8] The studies conducted that PW opening using VATS is the most effective technique with the lowest recurrence rate.[9]

The surgeon reaches the pericardium with a 5–8 cm vertical incision in the subxiphoid approach[10,11] and a submammary incision of 5 cm in thoracotomy.[12] Studies revealed that uniportal VATS is a good technique with a smaller incision and better cosmetic results.[13] In our study, we used only 2.5 cm incisions for the procedure.

Our technique provides the advantage of approaching the pericardium from both left and the right thoracic regions. Because PW opening with thoracotomy should be performed from the left side, it creates a handicap in patients with breast cancer who underwent a left mastectomy and/or radiotherapy.[12] In addition, a subxiphoid incision may complicate the approach in patients with large abdominal

Table 1: Detailed data of all patients' pre-, intra- and post-operative period

	Gender	Age, years	BMI	Pre-operative TTE/cm	Comorbidity	Symptom	Operation side	Operation time (min)	Peroperation drainage (mL)	Post-operation TTE	Complication	Discharge time/days
Patient 1	Female	39	21.7	4.0	IPAH	Dyspnoea	Left	35	850	≤0.5	None	1
Patient 2	Male	43	23.6	2.5	None	Fever + dyspnoea	Right	30	500	2	None	3
Patient 3	Male	47	39.8	2.5	MO	Dyspnoea	Right	60	750	≤0.5	None	1
Patient 4	Female	49	34.5	3.0	None	Dyspnoea	Left	40	200	≤0.5	None	1
Patient 5	Male	50	25.0	3.3	CHF + CAD	Dyspnoea	Right	50	850	≤0.5	None	2
Patient 6	Male	53	25.9	2.9	PKD	Dyspnoea	Left	60	600	≤0.5	None	3
Patient 7	Female	56	32.3	1.7	CHF	Dyspnoea	Left	30	500	≤0.5	None	1
Patient 8	Male	62	26.9	1.5	None	Dyspnoea	Right	4	350	1.0	None	1
Patient 9	Female	65	44.2	2.1	HT + ARF + DM + MO + AVO	Dyspnoea	Left	65	200	≤0.5	None	3
Patient 10	Male	66	34.3	2.5	HT + DM + CAD	Dyspnoea	Left	55	700	≤0.5	None	1
Patient 11	Male	69	26.3	4.0	LC + PAH + HT + AF	Dyspnoea	Left	30	1450	≤0.5	None	1
Patient 12	Female	78	35.6	3.2	HT + AF + CRF + MO	Dyspnoea	Left	55	800	≤0.5	None	1
Patient 13	Male	78	29.7	3.0	HT + SAVS + CAD + CVD	Dyspnoea	Left	40	550	≤0.5	None	1
Patient 14	Male	79	29.3	4.0	COPD + AF + CRF + PAH	Dyspnoea	Left	40	1100	≤0.5	None	1
Patient 15	Male	80	27.5	2.2	CLL + SMVR	Dyspnoea	Left	40	750	≤0.5	None	1
Patient 16	Female	81	25.3	3.7	HT + AF + PAH	Dyspnoea	Left	30	950	≤0.5	None	1
Patient 17	Female	83	22.8	1.9	SAVS	Dyspnoea	Left	20	500	≤0.5	None	4
Patient 18	Female	84	22.2	3.5	AF + STVR	Dyspnoea	Left	35	500	≤0.5	None	2
Patient 19	Male	85	28.7	1.5	HT + COPD + CAD	Dyspnoea	Left	55	950	≤0.5	None	1
Patient 20	Male	86	25.7	4.0	KS	Dyspnoea	Right	65	950	≤0.5	None	1

BMI (kg/m^2): Body mass index, TTE: Transthoracic echocardiography, PAH: Pulmonary artery hypertension, IPAH: Idiopathic PAH, MO: Morbidly obese, CHF: Congestive heart failure, PKD: Polycystic kidney disease, HT: Hypertension, ARF: Acute renal failure, DM: Diabetes mellitus, AVO: Aortic valve operation, LC: Cirrhosis of the liver, AF: Atrial fibrillation, SAVS: Severe aortic valve stenosis, CVD: Cerebrovascular disease, COPD: Chronic obstructive pulmonary disease, CLL: Chronic Lymphocytic Leukaemia, SMVR: Severe mitral valve regurgitation, STVR: Severe tricuspid valve regurgitation, KS: Kaposi sarcoma, CAD: Coronary artery disease, CRF: Chronic renal failure

Table 2: The mean and median variable values of the patients and operations

Variables	Median (IQR)	Variables	Mean±SD
Age, years	68 (52–81)	BMI, kg/m^2	29.1±6.0
Drain removal time, days	1 (1–1)	Pre-operative TTE, cm	2.8±0.9
Post-operative TTE, cm	0.1 (0–0.5)	Operation time, min	44±13.0
Discharge time, day	1 (1–2)	Perioperative drainage, mL	700±307

IQR: Interquartile range, BMI (kg/m^2): Body mass index, TTE: Transthoracic echocardiography, SD: Standard deviation

fat tissue,[4] which may pose a disadvantage in obese patients.

With VATS, all areas of the pericardium are visualised.[14] By combining the advantages of VATS, subxiphoid pericardiotomy and pericardiectomy,[15] not only the pericardium can be evaluated but also lung parenchyma, pleura and/or mediastinum.[8,10]

VATS is widely used in cardiothoracic surgery centres worldwide as the new gold standard for treating almost all thoracic diseases, with the advantages of less pain, fewer general complications and shorter hospital stays.[13]

The advantages and disadvantages of the 2 or 3-port VATS pericardiectomy procedure started by Mack *et al*.[7] have been emphasised in various studies.[10,11,15,16] Compared to the traditional VATS approach, post-operative pain and residual paraesthesia were reduced after single-port VATS.[17]

All surgical procedures, including thoracic surgery, cause stress-induced inflammatory responses and reduce immune system functions. Mechanical ventilation can deepen these adverse effects.[18]

Complications ranging from sore throat to tracheal rupture due to one-lung intubation are known. However, general anaesthesia with endobronchial intubation and single-lung positive pressure ventilation have always been considered mandatory to provide safe and optimal working conditions and surgical manipulation in thoracic surgery.[19,20]

Besides the intubation-related complications, single-lung ventilation is strongly associated with post-operative and mortal complications such as acute lung injury or adult respiratory distress syndrome.[21]

Some surgical centres do not support or prefer VATS in patients with tamponade or impaired respiratory functions because of the requirement of single-lung ventilation and lateral decubitus position.[15,22]

In patients with chronic pericardial effusion, anaesthesia-induced vasodilation may cause severe deterioration in cardiovascular function and acute tamponade may develop in a previously compensated patient.[23]

The subxiphoid window has the advantage of the possibility of operating under local anaesthesia.[24] However, pleural pathology is not accessible in the subxiphoid approach, which has no benefit, particularly in patients with posteriorly located and/or loculated pericardial effusion.[16] In addition, in the subxiphoid approach, fluid is drained into the mediastinum after pericardial resection,[10,11,14] and the window definition is incorrect because no real connection is established with the pleural space.[11]

Non-intubated thoracic surgery (NITS) is a surgical procedure performed with thoracic epidural or local anaesthesia in fully awake or spontaneously ventilated patients with mild sedation.[25] The complications associated with general anaesthesia, such as residual neuromuscular blockade, post-operative nausea and vomiting, ventilator-related lung injury and acute cardiac decompensation, can also be prevented with NITS.[26] To avoid these preventable complications, the use of the NITS technique is increasing.[25]

BMI ≥30 is considered a contraindication for non-intubated VATS.[20,25] In our study, the mean BMI was 29.1 ± 6,0 kg/m²; nine of our patients were overweight (BMI ≥25–30), three were obese (BMI ≥30–35) and three were morbidly obese (BMI ≥35); we had no difficulty in reaching the thoracic cavity during the procedure.

Malignancy is an important cause of pericardial effusion and two of our patients had malignancy (one patient had a new diagnosis). A clinical study emphasised that compliance with adjuvant chemotherapy in patients who underwent NITS was better than single-lung intubation.[27] For this reason, it can be considered another advantage of awake single-port VATS.

Gokce *et al*.[8] described their mean operation time for uniportal VATS under general anaesthesia as 35 (25–60) min, Georghiou *et al*. as 46 (30–60) min[15] and Geissbühler *et al*.[16] as 45 (30–60) min. The mean operation time was 43.7 ± 13.3 in our study and was similar to the results of other studies in the literature.

In a study by Celik *et al*.,[12] 30-day in-hospital mortality rate was 8.33% (died four patients) and was 8% in a study by Geissbühler *et al*.[16] In our study, the 30-day in-hospital mortality was 10% and our mortality rate was also consistent with the literature. Balla *et al*.[24] reported the morbidity rate as 21.7% (ten patients) and Geissbühler *et al*.[16] as 12% (three patients) in their studies. No morbidity was observed in our patients.

Gokce *et al*. were discharged patients on average postoperative day 2 (2.0 ± 1.75), while Geissbühler *et al*. were 10.4 days (4–33 days). The median length of stay was 9 days for subxiphoid and 7 days for anterior thoracotomy in a study by Balla *et al*.[8,16,24] Our median day of discharge and/or referral to the clinic where they are followed up due to comorbidities was 1 (1–2).

In our study, mediastinal and diaphragmatic movements continued during the surgical procedure because of the patient's spontaneous breathing. This situation caused deterioration of pericardial visualisation during expiration. Further narrowing of the visual field in the presence of tachypnoea and cough made surgical manipulation more difficult and could be accepted as a disadvantage.

Our study had several limitations. It is a retrospective single-centre study with a limited sample size, which limits the inference of the findings. Therefore, our study results should be evaluated with the inherent bias associated with retrospective studies and clinical practice.

CONCLUSIONS

Awake single-port minimally invasive thoracoscopic surgery could be used safely in all patient groups with pericardial effusion or tamponade as a diagnostic and therapeutic option. This technique has advantages, especially in patients with high surgical risk.

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Conflicts of interest

There are no conflicts of interest.

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