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Survival Following Video-Assisted Thoracic and Mini-Thoracotomy Pericardial Fenestration

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Objective: Surgical pericardial fenestration (sPF) is more invasive than interventional pericardiocentesis (PC) and requires general anesthesia. Severe complications such as ventricular puncture and chamber lacerations are, however, reported in association with PC and not with sPF. Is survival after sPF only determined by nonsurgical factors?

Methods: Between July 2000 and December 2015, data of all patients who had undergone sPF—either thoracoscopically or by anterior mini-thoracotomy—were investigated. The 2 techniques were analyzed retrospectively and the outcome (effectiveness, change in shock index) and the survival were assessed.

Results: 32 patients underwent 33 sPF. One-half of the patients had a benign underlying disease; the other half suffered from a malignant tumor. Four procedures were performed thoracoscopically and 29 via mini-thoracotomy. Both techniques were hemodynamically effective ($P < 0.0001$) in increasing blood pressure and decreasing pulse rate). There was no death due to failure to control the pericardial effusion and no procedure related mortality. Of the 16 patients with benign underlying disease 14 (87.5%) are still alive. Two died due to reasons unrelated to the procedure or the underlying disease. All 16 patients (100%) with malignant underlying disease died due to tumor progression.

Conclusions: In our patient cohort minimally invasive thoracic PF was safe and effective. The survival in our study was only related to the nature of the underlying disease. We conclude that sPF is an excellent procedure to treat pericardial effusions: both examined surgical techniques, thoracoscopic video assisted and access via mini-thoracotomy, were equally effective and safe.

Key words: Pericardial window techniques – Survival – Pericardial effusion – Pericardiocentesis – Severe complications – Underlying disease

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The etiology of pericardial effusion includes various diseases of benign and malignant origin. Pericardiocentesis (PC) and pericardial fenestration may be indicated for diagnostic or therapeutic reasons, or both. PC allows treatment of cardiac tamponade and cytologic assessment of pericardial effusions. Surgical pericardial fenestration (sPF) in addition allows better drainage of hemorrhagic effusions and tissue diagnosis.[1–7] Surgery can be performed thoracoscopically in hemodynamically stable patients or by mini-thoracotomy in the case of cardiac tamponade. Thoracoscopic sPF in particular offers a better overview for the assessment of additional pleural and pulmonary diseases and creates a larger window in the pericardium.

Severe complications such as ventricular puncture and chamber laceration as well as a recurrence rate of up to 26% have been reported in association with PC.[2] Although much smaller in patient numbers, studies investigating sPF reported fewer complications and a lower recurrence rate.[4–7]

The aim of our observational retrospective study was to quantify the efficiency and safety of sPF as well as the procedure mortality within of our patient cohort. The outcome was measured by change in the shock index, in-hospital mortality, postoperative complications, and operating and survival time.

Patients and Methods

From July 2000 to December 2015, data of all patients who underwent sPF procedures in the Department of Surgery of the Spital Thun STS AG were retrospectively analyzed. The study was approved by the Local Ethics Committee (Kantonale Ethikkommission Bern, KEK number 225/15). Written informed consent was obtained from each patient when possible. All patients were preoperatively investigated and diagnosed with electrocardiogram, chest X-ray, blood picture, and transthoracic echocardiography.

In hemodynamically stable patients thoracoscopic PF was performed under single-lung ventilation and with a 3-trocar access. A left-sided access was predominantly chosen unless the pericardial effusion was right-sided. Patients were positioned in the lateral decubitus position after double lumen intubation. The scope was inserted through the sixth intercostal space in the mid-axillary line and 2 additional 5 mm ports were introduced under vision according to the triangulation concept. Pericardiocentesis was performed under vision. A pericardial window was created with endoscopic scissors dorso-lateral to the phrenic nerve (Figs. 1–3). Patients with a cardiac tamponade underwent general anesthesia with both lungs ventilated. An anterior mini-thoracotomy with a length of 3 to 5 cm was performed. In females the skin incision was placed in the submammary skin fold, with the intercostal access being in the fifth intercostal space directly lateral to the phrenic nerve. In males the skin incision was placed directly above the intercostal access. Pleural or pulmonary procedures were performed as indicated. At the end of the operation a chest drain was inserted. We did not perform subxyphoidal pericardial fenestrations because simultaneous assessment of pleural and pulmonary disease is not possible. A full sternotomy was not indicated in any patient.

Outcome was measured by change in the shock-index, in-hospital mortality, postoperative complications, and operating and survival time.

The patients were extubated in theatre, transferred to intermediate care for 2 to 3 hours and afterward to the ward. The chest tube was removed when the drainage per 24 hours was below 100 mL. All patients were followed up with echocardiography by our cardiologists. The exact patient survival was established with the hospital follow-up case notes. According to the ethics committee conditions no patients, no relatives, and no local doctors were contacted.

Statistics

Statistical analysis was done using Wilcoxon matched-pairs signed-rank test for paired comparisons and Fisher's exact nonparametric multiple sample test on the equality of medians for non-paired comparisons. We used Spearman's rank correlation test, followed by a parametric correlation analysis to investigate correlations. All *P* values are 2-sided. Analyses were performed using Stata 12 (S-system).

Results

Over a time period of 15.5 years, 32 patients underwent 33 sPF. One of the patients had previously undergone a PC and presented with a recurrent pericardial effusion. Patient characteristics are summarized in Table 1. The median age of our cohort was 69 years with a wide range of 25 to 85 years. We operated on 13 female (41%) and 20 male

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(59%) patients. In 16 patients (50%) the underlying disease was benign, including 1 case where a perforating pacemaker electrode had caused an (acute) hematopericardium. A total of 14 patients had an unspecific or histologically not further classifiable pericarditis or pericardial changes. One patient had specific tuberculoid changes and mycobacterium tuberculosis was proven by PCR. In 1 case a perforating pacemaker electrode had caused an (acute) hematopericardium. A total 16 patients (50%) suffered from an underlying malignancy. Of these, the diagnoses were lung cancer (n = 8), breast cancer (n = 3), malignant mesothelioma (n = 2), colonic cancer (n = 1), and ovarian cancer (n = 1).

Four procedures were performed thoracoscopically and 29 via mini-thoracotomy.

The median operating time for mini-thoracotomy and thoracoscopy was 45 and 39.5 minutes, respectively, with no significant difference. Two patients underwent an additional pulmonary wedge resection in the same operation. A second chest drain was placed in the contralateral side 6 times.

Preoperative pulse rate (Pa) varied from 60 to 150 beats/min (mean: 101 ± 24), the systolic blood pressure (BPa) varied from 60 to 130 mmHg (mean: 99 ± 17 mmHg), and the quotient Pa divided by BPa (= shock-index) ranged from 0.5 to 2 (mean: 1.07 ± 0.38). In 1 patient the pulse rate of 60 beats/min was influenced by beta blockers. After the procedure the pulse rate (Pp) ranged from 60 to 110 beats/min (mean: 83 ± 16), and the systolic blood pressure (BPp) ranged from 100 to 188 mmHg (mean: 122 mmHg ± 20). The shock index varied from 0.35 to 0.95 (mean: 0.69 ± 0.15).

Overall, the 2 techniques were equally effective in significantly increasing the blood pressure and decreasing the pulse rate (both: $P < 0.0001$). Figure 4 shows the amount of pericardial effusion in relation to the change in the shock indices before and after the fenestration procedure. The volume of pericardial effusion ranged from 100 to 1600 mL in the benign group (mean: 559 mL ± 353) and from 200 to 1500 mL in the malignant group (mean: 706 mL ± 351). The overall mean volume was 635 mL ± 353. The change in the shock indices correlated with the volume of pericardial effusion (coefficient: 0.484; $P = 0.004$).

Minor postoperative complications occurred in 6 patients (18%). All of them underwent mini-thoracotomy. Two patients developed pneumonia. Cardiac arrhythmia was observed 3 times: once an atrial fibrillation that was successfully converted with amiodarone, once an atrioventricular block III° of

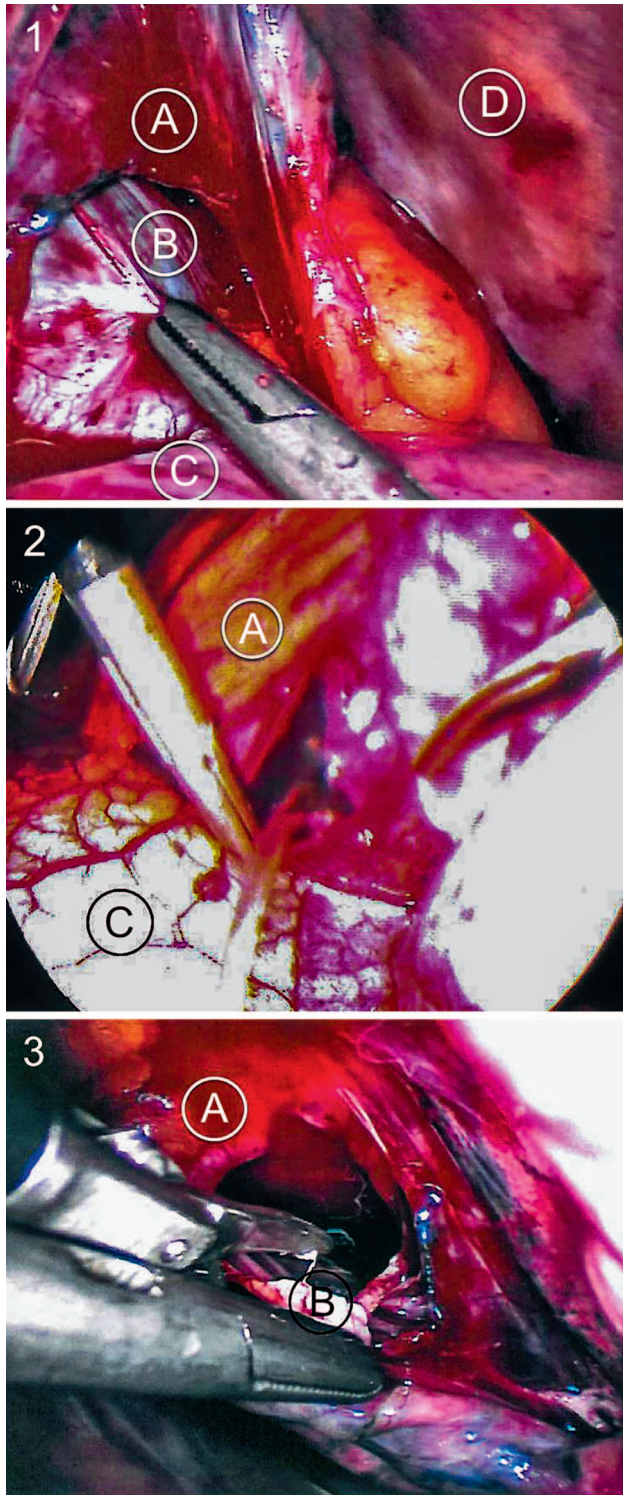

Figure 1–3 The following figures show a left-sided thoracoscopic pericardial fenestration: Fig. 1 Situs. Fig. 2 Opening of the pericard is performed under vision. Fig. 3 The pericardial window is created with endoscopic scissors dorso-lateral to the phrenic nerve. (A) Fibrous layer of pericardium. (B) Serous layer of pericardium. (C) Diaphragm. (D) Lung.

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Table 1 Patient characteristics

	Mini-thoracotomy (n = 29)	Thoracoscopy (n = 4)
Median age [y]	68 (43–85)	75 (25, 74, 76, 80)
Female / male	11 (38%) / 18 (62%)	2 (50%) / 2 (50%)
Benign / malignant	14 (48%) / 15 (52%)	2 (50%) / 2 (50%)
Median operating time [min]	44.5 (23–76)	39.9 (25, 28, 51, 65)

unknown origin that required external pacing, and a self-limiting supraventricular tachycardia. Another patient suffered from a temporary renal insufficiency.

There were no surgery-related mortalities and in all cases the sPF successfully controlled the pericardial effusion. The in-hospital mortality was 12% (4 patients). All deaths were attributable to progression of the underlying malignant disease. In 3 patients, therapy was changed to palliative care before they died.

A recurrent pericardial effusion was observed in 4 patients (12%). All of them suffered from malignancies. One patient had a recurrent loculated effusion on the right side of the pericardium after a sPF was done from the left. The patient underwent a second PF from the right 9 days after the first operation. He had a normal echocardiographic follow-up after 3 months. One patient developed a recurrent pericardial effusion 2 years after our sPF and was reoperated in another hospital. Two patients refused a second operation and palliative care was initiated.

Two of the 16 patients with a benign underlying disease died (12.5%). One patient died 386 days after the operation due to hypoglycemic shock. The second patient died 7 years and 105 days after the operation due to a pulmonary embolism.

The average follow-up time for these patients was 7.6 years.

All 16 patients (100%) with malignant underlying disease died due to tumor progression. The survival time ranged from 6 days to 22 months (mean: 132 days). Five of these 16 patients were excluded from registration of survival time as the latter could not be determined via the case notes. These 5 patients were in a palliative outpatient context and lived according to the cases note entries more than 3, 6, 7, and 10 months respectively after the operation.

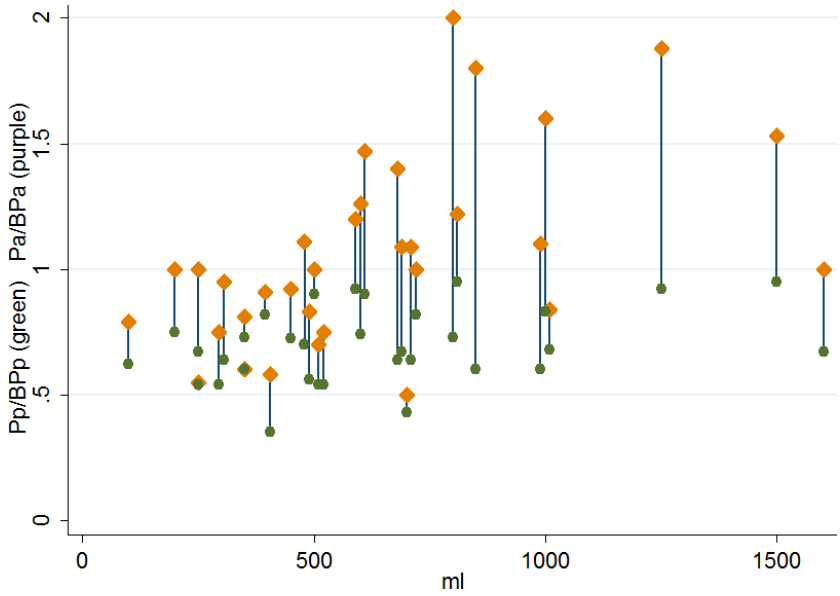

Fig. 4 Diagram of pericardial effusion (mL) versus the ratio of shock indices at the start (orange) and at the end (green) of the operation. The 2 techniques were equally effective in significantly increasing the blood pressure and decreasing the pulse rate (both: $P < 0.0001$).

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Discussion

In our patient cohort minimally-invasive sPF was a safe and effective procedure. Both surgical techniques—anterior mini-thoracotomy and thoracoscopy—had an immediate hemodynamic effect and the reduction in the shock index was highly statistically significant. Although all of our patients, in particular those with an underlying malignant disease, were seriously ill, the postoperative complication rate was low. In our small group treated totally thoracoscopically, no morbidity and no mortality were observed at all. These data correspond with the results of other series of sPF.[5–7] For obvious reasons, the recurrence rate in sPF is lower than in large studies for PC. None of our patients with benign underlying disease developed a recurrent pericardial effusion in a very long period of follow-up (2 to 15 years). Severe complications, as have been reported following PC, also did not occur in our patient cohort.

There are limitations to our study. Of course, the validity of our results is small due to the retrospective nature of our data analysis for a cohort of only 32 patients and without a control group.

However, in the literature, the number of patients in studies on thoracic pericardial fenestration is in general less than in our study.[4–7]

Furthermore, the 2 surgical techniques used in our hospital have their limitations. A thoracoscopic approach requires a hemodynamically stable patient and double lumen intubation. A kind of "positive selection" of the patients is obvious and can explain the absence of any postoperative morbidity in this group. Mini-thoracotomy is cosmetically less appealing, but the access can be performed very fast to control a pericardial tamponade. Other options for a surgical approach are subxyphoidal PF or sternotomy.

Subxyphoidal PF also guarantees rapid access,[6] but the overview is limited and additional pulmonary procedures cannot be performed. In contrast, the overview is maximal with a sternotomy access, which is ideal for multilocalized pericardial effusions or clotted intrapericardial hematoma. A full sternotomy is, however, the most invasive access. All surgical techniques result in good control of the pericardial effusion with a low recurrence rate.

Although an operation with general anesthesia is an intervention of higher complexity than PC, morbidity is low. We therefore conclude—based on our results and the recent literature—that surgical pericardial fenestration may be an excellent procedure to treat pericardial effusions and the survival after surgical pericardial fenestration may only depend on the nature of the underlying disease and not on the surgical procedure.

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