ORIGINAL ARTICLE

Ten-Year Surgical Experience With Nontraumatic Pericardial Effusions

A Comparison Between the Subxyphoid and Transthoracic Approaches to Pericardial Window

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Hypothesis: The approach to pericardial window in patients with nontraumatic pericardial effusion impacts outcome.

Design: Retrospective review and comparison of all cases of pericardial window performed over 10 years. Follow-up was to patient death.

Setting: Three hospitals performing cardiothoracic surgery at a single university.

Patients: All patients in whom pericardial window was performed for nontraumatic pericardial effusion.

Main Outcome Measures: Outcomes associated with the subxyphoid approach to pericardial window were compared with those associated with the transthoracic approach. The primary outcome was postsurgical recurrence of pericardial effusion. Secondary outcomes included operative time, intraoperative and postoperative complications, in-hospital mortality, hospital and intensive care unit lengths of stay, and days between surgery and death.

Results: Over 10 years, there were 342 patients with procedural codes for pericardial window in the medical record databases of 3 hospitals performing cardiothoracic surgery at 1 university center. One hundred fifty-one patients were excluded because the operation was performed for trauma, postoperative tamponade, or pericardial biopsy without effusion. The results are, therefore, based on the remaining 191 procedures. The subxyphoid approach was used in 78 patients, and the transthoracic approach in 113 patients. Patients were well matched for age ($P=.31$), sex ($P=.05$), preoperative tamponade ($P=.08$), and comorbidities ($P>.05$). No differences were observed between the 2 approaches in terms of recurrence of effusion, operative time, overall intraoperative or postoperative complications, and hospital or intensive care unit lengths of stay. In-hospital mortality was significantly greater in the subxyphoid group (27 of 78 vs 18 of 113 patients; $P=.003$).

Conclusions: Over 10 years, there were 191 pericardial windows performed for nontraumatic pericardial effusions. The subxyphoid and transthoracic approaches were well tolerated by patients, required short operative times, and resulted in similar rates of overall postoperative complications and intensive care unit and hospital lengths of stay. Recurrence rates were low with both procedures.

Arch Surg. 2005;140:191-195

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SURGICAL MANAGEMENT OF nontraumatic pericardial effusion differs between and within centers. There is some controversy regarding the most effective operation for the treatment of pericardial effusion in terms of recurrence and complication rates.

Pericardial effusions can occur secondary to multiple causes. Only a few patients with pericardial effusions will eventually develop symptoms or complications secondary to the effusion. For those who do become symptomatic, definitive surgical therapy is necessary to drain the effusion and prevent recurrence.

A pericardial window involves the excision of a portion of pericardium, thus allowing the effusion to continuously drain. The 2 main surgical approaches to pericardial window have been through the subxyphoid space or the thorax. Many surgeons primarily use one technique or the other, and the choice of procedure is usually based on surgeon preference, training, and/or experience. To our knowledge, there has been no evidence-based evaluation comparing these 2 approaches to pericardial window.

The present study was undertaken with the goal of comparing the outcomes between 2 approaches to pericardial win-

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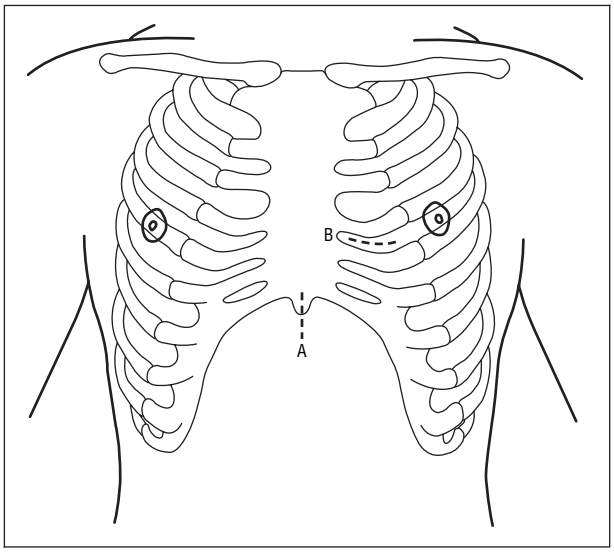

Figure. Subxyphoid (A) and transthoracic (B) incisions used for performing pericardial windows.

dow in the management of nontraumatic pericardial effusion. Although others have reported their experience with pericardial window,[1-7] to our knowledge, this series is the largest looking at the surgical management of nontraumatic pericardial effusion and the only to compare outcomes between the 2 most common approaches.

METHODS

This study consisted of a retrospective review of all cases of pericardial window performed for the treatment of nontraumatic pericardial effusion at a single university (McGill University). Three hospitals that perform cardiothoracic surgery (Montreal General Hospital, Royal Victoria Hospital, and Sir Mortimer B. Davis Jewish General Hospital) were used for patient identification. The study was approved by the institutional review board at all 3 hospitals. All patients who had undergone a pericardial window for any cause (surgical procedure code[8] 49.13 [pericardiotomy]) between April 1, 1992, and November 16, 2002 (Montreal General Hospital and Royal Victoria Hospital), and January 31, 2003 (Sir Mortimer B. Davis Jewish General Hospital), had their medical records pulled from archives at all 3 centers.

All medical records were manually reviewed. Any patient who had the procedure performed for postcardiac surgery tamponade, pericardial biopsy without window, or trauma was excluded. Two cohorts were defined based on the surgical approach to pericardial window (subxyphoid or transthoracic approach), as described in the surgeon's operative note. Choice of procedure was based on surgeon preference.

Patients were compared by baseline characteristics (age, sex, prior pericardiocentesis, tamponade, comorbidities, American Society of Anesthesiologists classification,[9] and time between diagnosis and procedure). Outcomes associated with the subxyphoid approach to pericardial window were compared with those associated with the transthoracic approach. The primary outcome was postsurgical recurrence of pericardial effusion. Secondary outcomes included operative time, intraoperative and postoperative complications, intraoperative mortality, in-hospital mortality, hospital and intensive care unit lengths of stay, and days between surgery and death. Operative time was defined as the time from incision until the time the patient left the operative room. Follow-up was to death or last follow-up clinic visit with any physician at the treating hospital, and was based on physician in-hospital and clinic notes.

SUBXYPHOID PERICARDIAL WINDOW

A short incision (about 5 cm long) is made over the xyphoid extending onto the midline of the abdomen (**Figure**, incision A). The linea is incised, and the xyphoid completely removed. The retrosternal space is entered by finger dissection. With upward retraction, the diaphragmatic aspect of the pericardium is visualized. The pericardium can be grasped with the hook or a pointed long clamp or can be incised directly. The opening in the pericardium is enlarged by finger dissection, and a protected sucker is inserted into the pericardial space and the fluid aspirated. A biopsy specimen is also taken from the pericardium. After all the fluid has been aspirated, the epicardium is inspected. A finger is introduced into the pericardial space to determine if there are any adhesions and if there are any nodules in the pericardium. Finally, through a separate stab wound, a tube is inserted into the pericardial space and connected to water seal drainage; the incision is closed in layers.

TRANSTHORACIC PERICARDIAL WINDOW

The operative exposure is achieved by a small anterior thoracotomy in the fourth or fifth intercostal space (Figure, incision B). An inframammary skin incision (6-8 cm long) allows division of the pectoralis muscle to expose the chosen intercostal space. The intercostal space is opened over the superior margin of the rib entering the pleural cavity. A retractor is placed, and samples of pleural effusion are obtained. The adjacent lung is palpated and a biopsy is easily performed if indicated.

The pericardium is visualized, and careful attention is paid to the phrenic nerve. The pericardium is usually bulging and can be incised anterior to the phrenic nerve with a scalpel or scissors. A generous window (2×3 cm) is created, and the pericardium is sent for pathological inspection. A small Silastic sump drain is placed into the pericardium and brought out through the sixth intercostal space and connected to low suction. A pleural tube is placed and connected to an underwater seal.

An alternative approach is to enter the pleural space via a subperiosteal resection of the fifth rib and adjacent costal cartilage.

STATISTICAL ANALYSIS

Outcomes associated with the subxyphoid approach to pericardial window were compared with those associated with the transthoracic approach. The primary outcome was clinically significant postsurgical recurrence of pericardial effusion, defined as the recurrence of pericardial effusion following pericardial window, requiring a second procedure, causing symptoms, or causing death. Secondary outcomes included operative time, intraoperative and postoperative complications, in-hospital mortality, hospital and intensive care unit lengths of stay, and days between surgery and death. Logistic regression was used to control for baseline characteristics in the analysis of the primary outcome.

RESULTS

Over 10 years, there were 342 patients with procedural codes for pericardial window in the medical record databases of 3 hospitals performing cardiothoracic surgery at 1 university center. One hundred fifty-one patients were

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Table 1. Number of Procedures Performed per Surgeon

No. of Procedures Performed	No. of Surgeons	Procedures per Surgeon, Mean (SD)
1	7	1.0 (0.0)
2-5	6	3.3 (1.2)
6-10	5	8.4 (1.3)
11-20	1	11.0 (0.0)
21-30	1	25.0 (0.0)
>30	2	43.0 (8.5)

Table 2. Underlying Cause and Location of the 191 Primary Tumors

Cause	No. (%) of Total
Malignancy*	**145** (75.9)
Lung	85 (44.5)
Breast	27 (14.1)
Lymphoma	14 (7.3)
Pleura (mesothelioma)	4 (2.1)
Leukemia	3 (1.6)
Thymus	3 (1.6)
Bladder	1 (0.5)
Colon	1 (0.5)
Kidney	1 (0.5)
Larynx	1 (0.5)
Liver	1 (0.5)
Prostate	1 (0.5)
Skin (melanoma)	1 (0.5)
Stomach	1 (0.5)
Tongue	1 (0.5)
Nonmalignancy*	**4** (2.1)
Aortic dissection	2 (1.0)
Bacterial cause	1 (0.5)
Amyloid	1 (0.5)
Unknown or idiopathic	**42** (22.0)

*Individual percentages do not sum to the total percentage for each grouping because of rounding.

excluded because the operation was performed for trauma, postoperative tamponade, or pericardial biopsy without effusion. The results are, therefore, based on the remaining 191 procedures performed by 22 different surgeons.

Table 1 describes the distribution of procedures by surgeon. Most procedures were performed by 3 surgeons, 1 of whom preferentially used the subxyphoid approach (32/49 [65.3% of this surgeon's cases]) and the other 2 who preferentially used thoracotomy (23/25 [92.0% of one surgeon's cases] and 34/37 [91.9% of the other surgeon's cases]). All procedures were performed by cardiothoracic surgeons. The mean±SD age of the sample was 56.3±14.1 years. There were 99 women (51.8%) and 92 men (48.2%). **Table 2** outlines the underlying cause of the effusion and the distribution of the location of the primary tumor responsible for the pericardial effusion.

The subxyphoid approach was used in 78 patients (40.8%) and the transthoracic approach in 113 patients (59.2%). Patients were well matched for age, sex, preoperative tamponade, and comorbidities (**Table 3**). Operative and postoperative outcomes for the 2 groups are described in **Table 4** and **Table 5**, respectively. Video-assisted thoracoscopy was used in 3 patients in the trans-

Table 3. Preoperative Characteristics*

Characteristic	Subxyphoid Group (n = 78)	Transthoracic Group (n = 113)	*P* Value
Age, y†	55.1 ± 13.5	57.2 ± 14.5	.31
Female sex	47 (60.3)	52 (46.0)	.05
Prior pericardiocentesis	28 (35.9)	37 (32.7)	.65
Preoperative tamponade (Beck triad)	10 (12.8)	26 (23.0)	.08
Preoperative pleural effusion	52 (66.7)	44 (38.9)	.43
Cardiac comorbidities	36 (46.2)	51 (45.1)	.89
Respiratory comorbidities	42 (53.8)	47 (41.6)	.10
ASA class 4 or 5‡	42 (66.7)	51 (48.6)	.02
Time between diagnosis and procedure, d†	2.2 ± 2.5	4.0 ± 5.2	.002

Abbreviation: ASA, American Society of Anesthesiologists.
*Data are given as number (percentage) of each group unless otherwise indicated.
†Data are given as mean±SD.
‡Percentages are "off" because not all data were available in patient charts.

Table 4. Operative Characteristics*

Characteristic	Subxyphoid Group (n = 78)	Transthoracic Group (n = 113)	*P* Value
Operative time, min	35.7 ± 23.5	39.5 ± 21.3	.25
Intraoperative fluid drained, mL	642 ± 392	685 ± 386	.57
Intraoperative death†	0	1 (0.9)	.41
Intraoperative complications†	4 (5.1)	5 (4.4)	.82

*Data are given as mean±SD unless otherwise indicated.
†Data are given as number (percentage) of each group.

Table 5. Postoperative Outcomes*

Outcome	Subxyphoid Group (n = 78)	Transthoracic Group (n = 113)	*P* Value
LOS, d†			
ICU	2.1 ± 2.8	3.1 ± 6.9	.16
Postoperative hospital	14.1 ± 16.4	16.1 ± 22.1	.46
Postoperative complications‡	0.94	0.84	.48
Cardiac	25 (32.5)	18 (16.4)	.01
Respiratory	18 (23.4)	31 (28.2)	.46
Fever	14 (18.2)	22 (20.0)	.76
Wound infection	1 (1.3)	5 (4.5)	.22
Recurrence of pericardial effusion	2 (2.6)	5 (4.4)	.50
Time between surgery and recurrence, d†	57.0 ± 77.8	57.3 ± 52.9	.48
In-hospital mortality	27 (34.6)	18 (16.1)	.003
Time between surgery and death, d†	12.4 ± 11.7	25.3 ± 23.5	.09
Follow-up, mo†	12.0 ± 16.5	10.0 ± 16.8	.49

Abbreviations: ICU, intensive care unit; LOS, length of stay.
*Data are given as number (percentage) of each group unless otherwise indicated. There was no incidence of phrenic nerve injury in either group. Most of the percentages are "off" because not all data were available in patient charts.
†Data are given as mean±SD.
‡Data are given as mean number per patient.

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Table 6. Pericardial Effusion Recurrence Rates in the Literature

Source	Follow-up, Mean	Effusion Recurrence*	
		Subxyphoid Group	Thoracotomy Group
Mueller et al,[2] 1997	4 y	12/62 (19)	Not app
Watarida et al,[4] 2002	16 mo	1/3 (33)	Not app
Dosios et al,[5] 2003	23.9 mo	2/99 (2)	Not app
Gregory et al,[6] 1985	NA (for both)	0/3	3/46 (6.5)
Little et al,[7] 1984	1-19 mo	1/30 (3)	Not app
Robles et al,[12] 1997	20.5 mo	Not app	0/22
Ohtsuka et al,[13] 1998	3-16 mo	Not app	0/9
Totté et al,[14] 2002	15 mo	0/12	Not app
Rodriguez et al,[15] 1999	4 wk	0/2	Not app
Santos and Frater,[16] 1977	NA	2/46 (4.3)	Not app
Hankins et al,[17] 1980	NA (for both)	0/13	0/4
Alcan et al,[18] 1982	22.6 mo	1/18 (5.6)	Not app
Prager et al,[19] 1982	NA	0/25	Not app
Snow and Lucas,[20] 1983	1.7 y	1/36 (2.8)	Not app
Ghosh et al,[21] 1985	NA	5/108 (4.6)	Not app
Piehler et al,[22] 1985	3.3 y	2/13 (15.4)	Not app
Reitknecht et al,[23] 1985	NA	2/46 (4.3)	Not app
Mills et al,[24] 1989	1.7-73.7 mo	14/123 (11.4)	Not app
Palatianos et al,[25] 1989	31.5 mo	1/41 (2.4)	Not app
Sugimoto et al,[26] 1990	120 d	2/28 (7.1)	Not app
Chan et al,[27] 1991	5 mo	2/22 (9.1)	Not app
Naunheim et al,[28] 1991	NA	3/38 (7.9)	Not app
Park et al,[29] 1991	2.67 mo	0/10	Not app
	1.23 mo	Not app	0/18
Campbell et al,[30] 1992	12 mo	3/25 (12)	Not app
Okamoto et al,[31] 1993	80 d	2/51 (3.9)	Not app
Van Trigt et al,[32] 1993	12 mo	9/57 (16)	Not app
Moores et al,[33] 1995	NA	4/155 (2.6)	Not app
Wilkes et al,[34] 1995	57 d-15 y	9/95 (9)	Not app
Allen et al,[35] 1999	2.2 mo	1/94 (1.1)	Not app
Porte et al,[36] 1999	50 mo (malignant)	1/44 (2)	Not app
	60 mo (nonmalignant)	4/66 (6)	Not app

Abbreviations: NA, data not available; Not app, data not applicable.
*Data are given as number/total (percentage).

thoracic group. Pericardial fluid cytological specimens were sent in 57 and 70 cases and were positive for malignancy in 22 and 19 patients (38.6% and 27.1%) in the subxyphoid and thoracotomy groups, respectively ($P=.12$).

There was one operative mortality (in the transthoracic group). The single operative death occurred secondary to a right ventricular injury in a patient who was undergoing a second pericardial window procedure and was unstable before anesthesia induction. The pericardium was adherent to the right ventricle, and the ventricle was entered during dissection. However, the injury was repaired; the patient was in critical condition and had requested preoperatively to not be resuscitated should he require it. He was not a candidate for cardiopulmonary bypass, and his pressure could not be maintained using vasopressors.

Following adjustment for preoperative confounders, risk of recurrence of pericardial effusion was not associated with either procedure (odds of recurrence, 0.38 [95% confidence interval, 0.05-2.64] for the subxyphoid vs the transthoracic approach).

COMMENT

We reviewed our experience with the surgical treatment of symptomatic pericardial effusion to ascertain whether there was a difference between the 2 most prevalent surgical approaches. Over 10 years, there were 191 pericardial windows performed for nontraumatic pericardial effusions at our university. The subxyphoid and transthoracic approaches were well tolerated, required short operative times, and resulted in similar rates of overall postoperative complications and intensive care unit and hospital lengths of stay. Recurrence rates were low and similar with both procedures. The lengthy duration of stay, high mortality rate, and severity of illness reflect the underlying disease process.

Postoperative care was similar for all patients; however, postoperative cardiac complications occurred with significantly greater frequency in the subxyphoid cohort. Possible explanations for this include decreased visualization of the heart through the subxyphoid compared with the transthoracic approach, with inadvertent minor injury to the myocardium. The presence of a pericardial sump remaining in the pericardium postoperatively may also be a factor in the increased incidence of postoperative complications with the subxyphoid approach. The differences in cardiac complications and in-hospital deaths in the subxyphoid group could also be attributed to their preoperative status at anesthesia induction (American Society of Anesthesiologists class 4 or 5, 18.1% higher in the subxyphoid vs the transthoracic group; $P=.02$).

Major limitations of the study include the retrospective nature of data acquisition and missing patients. Pure comparisons are difficult to interpret in a retrospective review of a center's experience. This is because of the fact that choice of procedure was by surgeon preference and the reality that not all surgeons had the same experience with the procedure. The lack of a standardized protocol for the operative technique also biases the results. This deficiency is somewhat decreased because of the fact that most procedures were performed by 3 surgeons, 1 of whom preferentially used the subxyphoid approach and the other 2 who preferentially used thoracotomy. The second major limitation of the study is that many patients were missed during the initial identification of eligible patients from the medical record databases. This is because of inaccuracies in surgical coding and the fact that if another procedure was performed during the same operation, coding typically was based on the major procedure.

Pericardial effusions can be managed using either percutaneous pericardiocentesis or surgery. Pericardiocen-

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tesis is associated with high rates of early recurrence[10] and, therefore, has been abandoned by most because it is not considered a definitive treatment for pericardial effusions.[11] Mueller et al[2] assessed the long-term results in 64 consecutive patients who underwent subxyphoid pericardial window over 11 years, and found that 18% of patients had a recurrence, with 50% of these requiring reoperation. We observed a 3.7% overall rate of recurrence of pericardial effusion following pericardial window. **Table 6** outlines the recurrence rates for pericardial effusion after pericardial window (using subxyphoid and transthoracic approaches) in the literature. Recurrence rates range between 0% and 33%.

Although minimally invasive surgery (video-assisted thoracoscopy) was only used in 3 patients in this series, it seems to have a role in the surgical management of pericardial effusions[12,13,37,38] and its use will probably increase in the future. Other minimally invasive techniques include laparoscopic transabdominal pericardial window[14,15,39] and percutaneous balloon pericardial window.[40,41]

In conclusion, to our knowledge, this is the largest series to report on the surgical creation of pericardial window and the first to compare the subxyphoid with the transthoracic approach. Pericardial window in the definitive management of nontraumatic pericardial effusions is well tolerated, is associated with low complication rates and postoperative morbidities, and is not significantly affected by the route chosen to approach the pericardium.

Accepted for Publication: August 11, 2004.
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Acknowledgment: We thank Anne Hubert for providing the figure for this article.

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