Posterior Pericardial Drainage in Patients with Heart Surgery

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ABSTRACT

Aim of the Study: To assess the merits and demerits of posterior pericardial drainage in patients undergoing heart surgery.

Materials and Methods: A systematic review and meta-analysis of observational studies and randomized controlled trials was conducted. We searched for relevant trials in the Cochrane Library, MEDLINE (from 1980), Embase from 1970 the Transfusion Evidence Library from 1980, and ongoing trial databases; all searches current to 30 September 2017.

Results: The search yielded Sixteen randomized controlled trials which included 2755 patients. Results revealed that Posterior pericardial drainage was associated with a significant 90% reduction of the odds of cardiac tamponade versus the control group: (OR 95% confidence interval) 0.13; $P < 0.001$. The ORs of death or cardiac arrest were significantly decreased by approximately 50% in the posterior pericardial drainage group compared to controls: OR (95% CI): 0.47, P = .028; I2 = 0%

Conclusion: Posterior pericardial drainage has been reported in the literature to significantly reduce the prevalence of early pericardial effusion as well as cardiac tamponade. A significant enhanced survival rate was recorded postcardiac surgery.

Keywords: posterior pericardiotomy; systematic review, atrial fibrillation; cardiac tamponade; coronary artery bypass grafting, pericardial effusion.

INTRODUCTION

Pericardial effusion is a common finding in clinical practice either as incidental finding or manifestation of a systemic or cardiac disease. The spectrum of pericardial effusions ranges from mild asymptomatic effusions to cardiac tamponade. Moreover, pericardial effusion may accumulate slowly or suddenly[(1)].

Pericardial effusion is very common after cardiac surgery. Despite the high incidence of effusion, the clinical approach to this problem remains controversial. Once pericardial effusion is documented, serial echocardiographic studies are frequently performed, at considerable expense[(2)].

Unfortunately, there are few epidemiological data on the incidence and prevalence of such effusions in the clinical setting. In Maria Vittoria hospital, an urban general hospital in Torino and an Italian referral center for pericardial diseases, the mean annual incidence and prevalence of pericardial effusion have been, respectively, 3 and 9% in a 6-year experience of the echo laboratory (2000–05) [(3)]. Such data mainly depend on the epidemiological background (especially developed vs. developing country, where tuberculosis is a leading cause of pericardial disease and concurrent HIV infection may have an important promoting role) [(4)], the institutional setting (tertiary referral centercompared to secondary and general hospitals), and the availability of specific subspecialties (especially nephrology, rheumatology, and oncology). Furthermore, since postoperative PE or pericardial tamponade (PT) may present without prominent clinical signs and findings, there is a potential risk for life-threatening events. The delayed presentation of PE or PT may arise several days to weeks after the operation. In these clinical situations, early diagnosis would aid in the early treatment[(5)].

Pericardial drainage procedures can be performed for diagnostic or therapeutic purposes (patients with cardiac tamponade). In patients without hemodynamic compromise the diagnostic yield of pericardial fluid or pericardial tissue is very low[(6)]. Patients with echocardiographic collapses rarely require pericardial drainage for therapeutic purposes during the initial admission. Therefore, pericardial drainage procedures are not justified on a routine basis in patients without hemodynamic

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compromise. Three exceptions to this rule should be noted. Patients with a strong suspicion of purulent or tuberculous pericarditis merit invasive pericardial procedures[7]. In contrast, in patients with underlying malignancies examination of pericardial fluid is indicated so as to determine whether the effusion is secondary to neoplastic pericardial involvement or is an epiphenomenon (non-malignant effusion) related to the management of the cancer (such as previous thoracic irradiation) or effusions of unknown origin[7]. In a nutshell, a wide variety of pathologic conditions may cause pericardial effusion leading to pericardial tamponade. Cardiac tamponade requires drainage to prevent cardiac decompensation and death. The effusion can be drained by needle or catheter pericardiocentesis, subxiphoid pericardial drainage[8],pericardial window performed through a left anterior thoracotomy[9], pericardiectomy performed by an open thoracotomy[10], or video-assisted thorascopic (VATS) pericardiectomy[11]. The most effective method of drainage to prevent recurrence is subject to controversy[12]. In the present study, our primary goal was to assess the benefits and drawbacks of posterior pericardial drainage in patients undergoing heart surgery.

MATERIALS AND METHODS

Data Sources

Literature searches of MEDLINE, EMBASE, SCOPUS, Current Contents, Cochrane Library, and Clinical trials.gov between 1980 and 2017 were performed. The search terms were used in combinations and together with the Boolean operators .and 16 articles matched the stipulated criteria and were included in the current review.

Search terms: “pericardiotomy,” “pericardial incision,” “pericardial window,” “posterior pericardiotomy,” “pericardial drainage,” “posterior pericardium drainage,” “posterior pericardial chest tube,” “additional chest tube,” “randomized,” and “study/trial.”

Study Selection and Criteria

Search results were screened by scanning abstracts for the following

Inclusion Criteria

1- Randomized controlled trials (RCTs) and controlled clinical trials (CCTs).

2- Study comparing strategy of posterior pericardial drainage with no intervention to the pericardium during heart surgery.

3- Studies reporting outcomes of interest within the investigated follow-up.

Exclusion Criteria

1- Narrative reviews or case reports.

2- Non RCTs.

The study was done according to the ethical board of King Abdulaziz university.

Statistical Analysis

- Cochran Q test was used.
- **Primary index Statistics**: Odds ratios (ORs) and 95% confidence intervals (CIs) as for dichotomous outcomes.
- **Continuous outcomes**: mean difference and corresponding 95% CIs calculated by the use of a random effects model.
- Pooled ORs were calculated via the Mantel-Haenszel model [13]with weight assigned to each included study adjusted to include a measure of variation (τ^2) in the effects reported between studies.
- In the case that degree of heterogeneity exceeded 40%, an inverse variance (DerSimonian-Laird) random-effects model was applied.

As a preferred approach when intervention effects are small (ORs are close to one) and events are not particularly common, estimates were calculated by the use of the fixed-effects Peto method[14]. In case there were “0 events” reported in both arms, calculations were repeated, as a sensitivity analysis, by the use of risk difference and respective 95% CIs.

Moreover, an attempt was made to explore the possible relationship between age, sex, hypertension, type 2 diabetes, type of the surgery, mean number of grafts, duration of cardiopulmonary bypass, cross clamp, and study total number of patients and the occurrence of primary endpoint.

v. 2 (Biostat, Englewood, NJ) [15] were used for statistical computations. *P* values $\leq$.05 were considered statistically significant and reported as 2-sided, without adjustment for multiple comparisons.

RESULTS

Searches identified 1174 publications in addition to another 21 publications that were found through manual research. After removal of duplicates, abstracts and titles,733 publications were assessed as identified from title and abstract, and 230 papers were excluded. 87 papers full text could not be retrieved and another 340 papers with the same cohort. There were also 317 papers excluded because they did not compare different surgical techniques or did not report an adhesion-related outcome. We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [16]guide lines in reporting the results. **Figure 1**

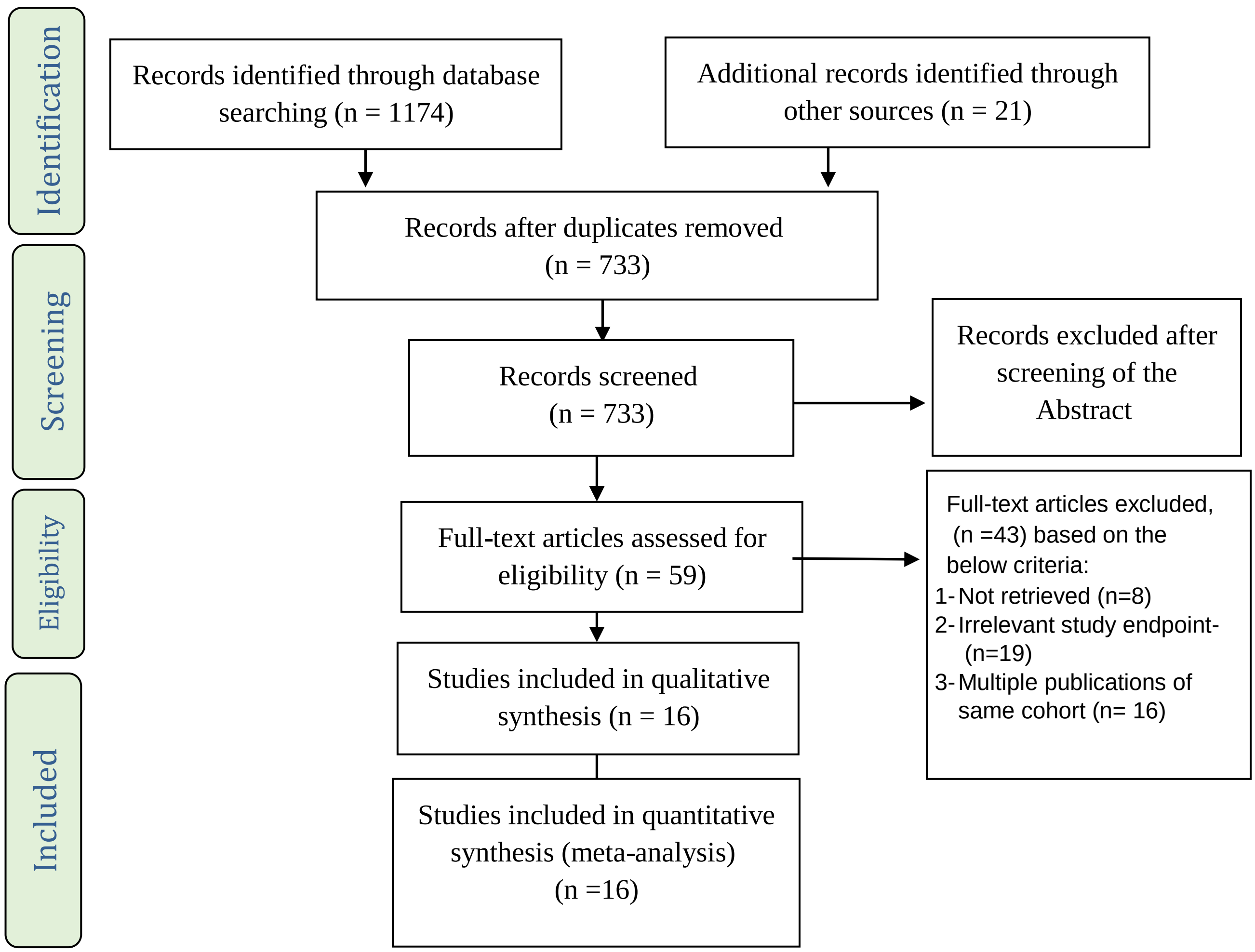

Figure 1: PRISMA flow diagram showing the selection criteria of assessed the studies[16].

Most of the studies included 2 drains which were placed at the end of surgery: one in the left pleural cavity while the other was placed in the anterior mediastinum, the pericardium however was left open anteriorly. PP was and comprised a longitudinal, 4-cm long incision parallel and posterior to the phrenic nerve, extending from left inferior pulmonary vein to the diaphragm in most cases.

Zhao et al. [25] reported intervention-related complications; one case of postoperative bleeding due to dropping of the hemoclip from the inverse-T incision**.**

Furthermore, Tables 1 represents baseline characteristics of all studies included in the present meta-analysis while table 2 demonstrates the secondary medical condition of the cases

Table 1: Characteristics of the included studies

Authors	Year	Patients' numbers	Mean age(years)	Male (%)	Setting	Intervention
Arbatli *et al.* (17)	2003	54	62 ± 8	83	CABG	Posterior pericardiotomy
		59	60 ± 9	74		Control
Ekim *et al.* (18)	2006	50	59 ± 9	66	CABG	Posterior pericardiotomy
		50	60 ± 3	64		Control
Eryilmaz *et al.* (19)	2006	70	55 ± 7	41	Valve replacement	Additional chest tube
		70	56 ± 7	46	Ascending aorta surgery	Control
Bakhshandeh*et al.* (20)	2009	205	67 ± 8	38	CABG	Posterior pericardiotomy
Bakhshandeh*et al.* (21)	2009	205	68 ± 9	42	Valve replacement	Control
Bolourian *et al.* (22)	2011	87	60 ± 11	71	CABG	Posterior pericardiotomy
		87	60 ± 10	71		Control
Sadeghpour et al (23)	2011	40	61 ± 8	78	CABG	Posterior pericardiotomy
		40	60 ± 13	80		Control
Kaygin *et al.* (24)	2011	213	59 ± 11	50	CABG	Posterior pericardiotomy
		212	59 ± 11	50		Control
Zhao *et al.* (25)	2014	228	54 ± 16	60	CABG	Posterior pericardiotomy
		230	56 ± 18	54	Valve replacement	Control
Kaya *et al.* (26)	2014	30	60 ± 10	77	CABG	Posterior pericardiotomy
		33	59 ± 8	76		Additional chest tube
		33	59 ± 11	88		Control
Fawzy *et al.* (27)	2015	100	54 ± 9	64	CABG	Posterior pericardiotomy
		100	56 ± 10	68		Control
Haddadzadeh *et al.* (28)	2015	105	61 ± 10	69	OPCAB	Posterior pericardiotomy
		102	61 ± 11	69		Control
Kaya *et al*(29).	2015	70	58 ± 9	86	CABG	Posterior pericardiotomy + additional chest tube
		72	56 ± 9	81		Control
Kaya *et al.* (30)	2016	103	58 ± 9	78	CABG	Posterior pericardiotomy + additional chest tube
		107	57 ± 9	79		Control

Table 2: summary of the medical conditions of patients enrolled in the included studies

Authors	CPB (min)	Crossclamp, (min)	Hypertension(%)	DM, (%)	Grafts (Mean no.)
Arbatliet al. [17]	117 ± 32	58 ± 17	61	26	2.9 ± 0.9
	112 ± 35	60 ± 19	59	26	2.9 ± 0.9
Ekimet al. [18]	89 ± 21	63 ± 19	52	20	2.8 ± 0.4
	87 ± 26	62 ± 12	48	22	2.7 ± 0.9
Eryilmaz et al. [19]	171 ± 22	NR	NR	NR	NA
	176 ± 19				
Bakhshandeh et al. [20]	NR	NR	55	40	3.2 ± 0.9
Bakhshandeh et al. [21]			46	47	3.3 ± 0.7
Bolourian et al. [22]	95 ± 38	56 ± 24	47	NR	3.4 ± 0.7
	94 ± 38	54 ± 22	47		3.1 ± 0.9
Sadeghpour et al. [23]	NR	NR	NR	65	3.2 ± 0.7
				37	3.5 ± 1.5
Kaygin et al. [24]	NR	NR	NR	55	NR
				56	
Zhao et al. [25]	110 ± 46	67 ± 29	41	43	NR
	103 ± 51	62 ± 23	39	47	
Kaya et al. [26]	80 ± 26	43 ± 16	50	53	3.37 ± 1.19
	82 ± 21	43 ± 15	70	61	3.18 ± 0.85
	86 ± 27	46 ± 21	55	36	3.0 ± 0.90
Fawzy et al. [27]	89 ± 29	55 ± 21	56	48	2.7 ± 0.6
	87 ± 23	59 ± 17	54	46	2.6 ± 0.4
Haddadzadeh et al. [28]	NA	NA	55	41	2.1 ± 0.7
			44	31	2.1 ± 0.7
Kaya et al.[29].	78 ± 20	44 ± 13	44	56	3.33 ± 0.94
	80 ± 23	45 ± 13	40	57	3.15 ± 0.69
Kaya et al. [30]	82 ± 26	45 ± 19	47	47	3.01 ± 1.08
	77 ± 23	43 ± 15	38	53	2.88 ± 0.85

CPB*:* Cardiopulmonary bypass, **crossclamp,** aortic cross clamp; *HT*, hypertension; *DM*, diabetes mellitus; *CABG*, coronary artery bypass grafting; *nd*, not done; *NR*, not reported; *NA*, not applicable; *OPCAB*, off-pump coronary artery bypass.

Primary Endpoint

A funnel plot constructed for the primary endpoint revealed signs of moderate asymmetry (Figure E1, *A*), but this was not significant (Egger test, $P = .11$). Fourteen studies ($n = 2844$) were included. Individual and overall ORs for cardiac tamponade are depicted in Figure 2.

Posterior pericardial drainage was associated with a significant approximately 90% reduction of the odds of cardiac tamponade compared with the control group: OR (95% CI) 0.13 (0.07-0.25); $P < .001$; $I^2 = 0\%$ in the fixed-effects model. The corresponding event rates were 0.42% (6/1431) versus 4.95% (70/1413).

Table 3: comparison between posterior pericardial drainage (intervention) and control group for prevention of primary endpoint cardiac tamponade after heart surgery

		Intervention		Control		OR
Authors	**Year**	**Events**	**Total**	**Events**	**Total**	**Fixed, 95% CI**
Arbatli et al.[17]	2003	0	54	0	59	Can't be estimate d
Ekim et al.[18]	2006	0	50	1	50	0.33
Eryilmaz et al.[19]	2006	2	70	6	70	0.31
Bakhshandeh *et al.*[20]	2009	0	205	10	205	0.05
Kaygin *et al*.[24]	2011	0	213	7	212	0.06
Zhao *et al*.[25]	2014	3	228	13	230	0.22
Kaya *et al*.[26]	2014	0	63	4	33	0.05
Fawzy *et al*.[27]	2015	0	100	3	100	0.14
Kaya *et al*.[29]	2015	1	70	1	72	1.03
Kaya *et al*.[30]	2016	0	103	4	107	0.11
total (95% CI)		1156		1138		0.12

Death or Cardiac Arrest

No signs of publication bias detected in the analysis of mortality or cardiac arrest (Table 4).

Seven RCTs enrolling 932 patients provided data for the analysis. The ORs of death or cardiac arrest were significantly decreased by roughly 50% in the posterior pericardial drainage group compared with controls: OR (95% CI): 0.47, $P = 0.028$; $I2 = 0\%$.

There were 11 deaths (1.18%) or cardiac arrests compared with 23 (2.53%), respectively, in the posterior pericardial drainage and control groups.

Table 4: comparison between posterior pericardial drainage (intervention) and control group for prevention of death or cardiac arrest after heart surgery.

Authors	**Year**	**Intervention**		**Control**		**OR**
		Events	**Total**	**Events**	**Total**	**Fixed, 95% CI**
Ekim *et al*.	2006	0	50	0	50	NA
Bakhshandeh *et al.*	2009	7	205	11	205	0.63
Kaygin *et al.*	2011	3	213	4	212	0.74
Zhao *et al.*	2014	1	228	5	230	0.25
Kaya *et al.*	2014	0	63	2	33	0.05
Kaya *et al.*	2015	0	70	0	72	NA
Kaya *et al.*	2016	0	103	1	107	0.14
Total (95% CI)		11	932	23	909	0.47

DISCUSSION

In the present systematic review and meta-analysis we attempted to analyze and evaluate the potential beneficial value of a posterior pericardial drainage after heart surgery. The key finding was the high effectiveness of posterior pericardial drainage in preventing cardiac tamponade as well as mortality without jeopardizing safety.

Primarily, the present meta-analysis included 16 RCTs and 2755 patients and evidently demonstrated significantly reduced odds of death or cardiac arrest.

Statistically, even though there were no differences for the total volume of chest tube drainage, more pleural effusions (requiring intervention or not) were reported in the intervention arm, nevertheless, this did not lead to a higher incidence of pulmonary complications when compared to the control group.

Furthermore, delayed-onset pericardial effusion after heart surgery may produce significant morbidity in addition to management by traditional surgical techniques involving resternotomy.

The pericardial fluid collected in a gap in front of the heart usually is easily drained via a chest drain; however, because pericardial adhesions are frequently observed between the inferior and posterior surfaces of the heart and the diaphragm, they may create an enclosed gap that makes drainage difficult [(31)]. The use of our pericardiotomy technique enables better drainage of the pericardial fluid and prevents the formation of effusion or tamponade.

Naturally, PP is performed as a longitudinal, 4-cm long incision parallel and posterior to the phrenic nerve, coveringthe whole area from the left inferior pulmonary vein to the diaphragm[(32)]. This allows unobstructed drainage of the blood and fluids from the pericardium directly to the pleural space.

PP is easy to perform and it is cost-effective. Compared to a simple chest tube drainage, however, PP may not be entirely free from intervention-related complications; and a potential risk of cardiac herniation[(33)].

These complications may be minimized by performing a limited PP at the end of the procedure at a distance from the bypass grafts.

Nevertheless, it's important to mention that Meta-analyses of studies conducted so far are not conclusive regarding the prevention of cardiac tamponade, and guidelines. Recommendations are still weak with regard to routine posterior pericardial drainage.

Still, it's evident in the present study that PP's true benefit in the reduction of incidence of cardiac tamponade which in turn reflects lower odds of mortality or cardiac arrest results.

Numerous mechanisms were proposed to predispose to POAF. One of which is a hypothesis that a certain amount of fluid/hematoma into the pericardium may represent a mechanical irritating stimulus to the atria, whose function can be affected by external compression.

To sum up, the assessment of safety and effectiveness of PP study significantly justified their roles in the reduction of the incidence of pericardial effusion and, accordingly, reducing the incidence of supraventricular arrhythmias in the postoperative period.

CONCLUSION

Posterior pericardial drainage has proven to be an easy , safe and effective technique that significantly reduces not only the prevalence of early pericardial effusion and related POAF but also delayed pericardial effusion and cardiac tamponade. These benefits, in turn, translate into lower odds of AKI and improved survival after heart surgery.

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