THE ANATOLIAN JOURNAL OF CARDIOLOGY

Official journal of the TURKISH SOCIETY OF CARDIOLOGY

Pleuropericardial Window Prevents Pericardial Effusion Following Surgical Atrial Septal Defect Closure

ORIGINAL INVESTIGATION

ABSTRACT

Background: Pericardial effusion occurs frequently after surgical atrial septal defect closure. This complication carries the risk of development of cardiac tamponade and death. It is also the responsibility of the hospital for readmissions. Any measure in preventing the development of pericardial effusion is of paramount importance. In this report, our objective was to demonstrate the protective effect of creating a pleuropericardial window against the development of postsurgical pericardial effusion.

Methods: Hospital records of all patients who underwent surgical atrial septal defect closure between January 2015 and December 2020 were reviewed. Patients were divided into 2 groups according to the creation of right/left pleuropericardial window during surgical ASD closure. There were 45 patients in group I in which a right pleuropericardial window was done, and 85 patients constituted group II in which pericardium was left intact.

Results: None of the 45 patients in group I developed pericardial effusion, while 15 of 85 patients in group II developed pericardial effusion ($P = .001$). Ten patients developed more than mild pericardial effusion which required medical treatment, while 5 patients had to be re-hospitalized because of massive pericardial effusion and effusions were managed by percutaneous drainage.

Conclusions: The creation of a right pleuropericardial window resulted in a safe postoperative recovery after surgical atrial septal defect closure in all patients with the development of no pericardial effusion. No adverse effect of the creation of a pleural communication was noted.

Keywords: Atrial septal defect closure, open-heart surgery, pericardial effusion, postpericardiotomy syndrome, pleuropericardial window

INTRODUCTION

Pericardial effusion, usually in the form of postpericardiotomy syndrome (PPS) is by far the most common morbidity after surgical closure of atrial septal defect (ASD), as it is for all cardiac operations for adults and children. Our main idea was to prevent postoperative pericardial effusion in advance. In this context, any measure in preventing the development of pericardial effusion is of paramount value.

Accumulation of excess fluid within the layers of the pericardial sac is defined as pericardial effusion. Any pathological inflammatory state leading to increased production or any mechanism such as increased systemic venous pressure causing a decreased absorption of the fluid results in pericardial effusion.[1] Cardiac surgery is one of the most common causes. Clinical manifestation of pericardial effusion depends on the rate of the accumulation. Pericardial effusion can cause mortality if it remains undetected. It is also responsible for readmissions after discharge.

Prevention of the development of pericardial effusion following cardiac surgery, like its treatment, has been a major concern in order to protect patients from this mortal complication. The creation of a pleuropericardial window is a well-defined surgical method of treating persistent or recurrent pericardial effusion. Here, we integrated the creation of a right-sided pleuropericardial window in surgical closure of ASD. We consider that this method decreases the mortality and

Murat Özkan
Deniz Sarp Beyazpınar
Mehmet Çelik
Çağrı Günaydın

Department of Cardiovascular Surgery, Faculty of Medicine, Başkent University, Ankara, Turkey

Corresponding author:
Murat Özkan
ozkan.mrt@gmail.com

Received: February 2, 2022
Accepted: March 23, 2022
Available Online Date: May 16, 2022

Cite this article as: Özkan M, Beyazpınar DS, Çelik M, Günaydın Ç. Pleuropericardial window prevents pericardial effusion following surgical atrial septal defect closure. *Anatol J Cardiol.* 2022;26(9):696-701.

DOI:10.5152/AnatolJCardiol.2022.1686

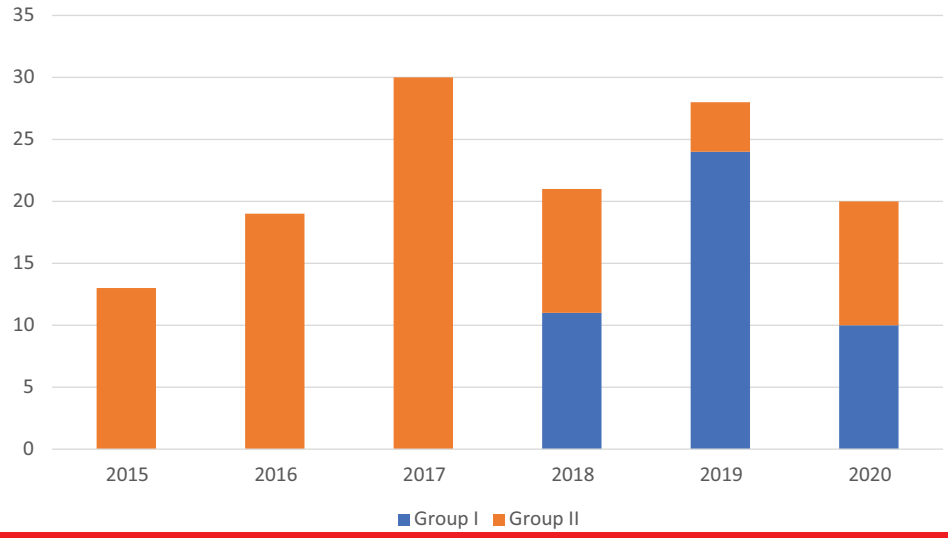

Figure 1. Annual number of patients in group I and group II.

morbidity rates in patients undergoing ASD surgery by preventing the development of postoperative pericardial effusion complications.

Our intention was to reduce the incidence of the development of pericardial effusion thus prevent a possible cause of mortality after ASD closure. We believe that this technique is a readily used, reproducible, safe method for the prevention of pericardial effusion after surgical ASD closure.

METHODS

Study Population

Hospital records of all patients who underwent surgical ASD closure between January 2015 and December 2020 were reviewed. Written informed consent about the surgical procedure was collected from every patient. The study was evaluated by the Local Ethics Committee of Başkent University. Two hundred eleven files were retrieved. Thirteen patients who had ASD closure via right submammary thoracotomy were excluded. The pericardial incision was closed with 2 interrupted sutures and practically they all had a pleuropericardial window. In this subset of patients, none experienced any episode of pericardial effusion during the follow-up. The remaining 198 patients who were operated through a sternotomy were divided into 2 groups according to the presence of pleuropericardial window. During the study period, 105 patients underwent transcatheter ASD closure.

The first patient with a pleurpericardial window was operated in March 2018 after an unfortunate incident. All patients who were operated by one author (M.O.) were operated with a pleuropericardial window since then.

A right pleuropericardial window was applied in 58 patients. Patients who had a fenestrated patch because of an undersized left ventricle and patients who had repair of mitral, tricuspid, or pulmonary valves in conjunction with ASD closure were excluded. These conditions could cause pleural or pericardial effusions. Seven of 52 patients in group I lacked postoperative follow-up in our institution, therefore excluded. Forty-five patients were defined as group I (aged between 13 months and 12 years).

One hundred and forty patients had ASD closure with no pleuropericardial window. Redo patients were excluded because they already had pericardial adhesions which might affect the collection of pericardial fluid. Patients who had a fenestrated patch closure and patients who had an additional valvular intervention were excluded. Thirty-one patients had their right pleural cavities opened during the surgery unintentionally and chest drains were left in place at the end of the surgery. These patients were also excluded since pleural communications could affect the outcome. Forty patients were excluded for all reasons. Nine patients lacked postoperative data in our institution so were excluded. Eventually, 85 patients were defined as group II (aged between 9 months and 15 years). Annual numbers of patients in each group were demonstrated in Figure 1.

Surgical Method

All patients were operated under general anesthesia. A full split or lower partial sternotomy was done. Thymus was not resected. Cardiopulmonary bypass was commenced with aortic and bicaval cannulation. Cardioplegic arrest was

HIGHLIGHTS

- Pericardial effusion following surgical closure of atrial septal defect is a common complication.
- Pericardial effusion can be lethal if it progresses to pericardial tamponade.
- Medical measures have not been shown to be effective in the prevention of postoperative development of pericardial effusion.
- The creation of a pleuropericardial window as a component of the surgical procedure is an effective method of preventing postoperative pericardial effusion.

achieved with an infusion of cold crystalloid cardioplegia applied via aortic root cannula. The atrial septal defect was closed by primary suturing in three-quarters of patients, a patch closure was done in the other quarter. Aortic cross-clamp duration and cardiopulmonary bypass duration for group I were 17 ± 6.5 minutes and 40 ± 13 minutes, respectively. They were 13 ± 5 minutes and 32 ± 7.1 minutes for group II.

In order to create a pleuropericardial window in patients in group I, a hockey stick incision was done parallel and anterior to the right phrenic nerve during rewarming. Cannulae were removed after weaning from bypass. A single curved chest drain was left in the right pleural cavity which was placed through the window and the pericardium was closed with 2 interrupted sutures. In patients who did not have a pleuropericardial window, a straight chest drain was left in the mediastinal cavity, placed anterior to the heart. The pericardium was left open in those cases.

Postoperative Course

All patients left the operating theater intubated and transferred to the intensive care unit (ICU). Most of them were extubated in the ICU on the same day. The patients commonly left the ICU the following day and transferred to the ward. The chest drains were removed mostly the day after the patients left the ICU. No chest drain was kept longer than 4 days in any patient.

Statistical Analyses

The statistical analyses were made by using IBM® SPSS® (Statistical Package for the Social Sciences). The normality of distribution for continuous variables was assessed by Kolmogorov-Smirnov test. Group statistics were done with an independent sample *t*-test for variables with normal distribution and with Mann–Whitney *U*-test for non-normal distribution. Categorical variables were analyzed by chi-square test or Fisher's exact test according to the table type and the size of the expected frequencies. The *P*-value smaller than .05 was accepted as significant.

Table 1. Preoperative Demographic Characteristics and Operative Data

	Group I n = 45	Group II n = 85	*P*
Age (months) (median, IQR)	46 (29-62)	46 (29-73)	.529
Height (cm) (mean ± SD)	99.6 ± 18.5	103.5 ± 22.7	.321
Body weight (kg) (median, IQR)	15 (14-20)	17 (13-21)	.553
Patch use in ASD closure n (%)	12 (26.7%)	15 (17.6%)	.152
Cross clamp time (mean ± SD)	17 ± 6.5	13 ± 5	.212
CPB time (mean ± SD)	40 ± 13	32 ± 7.1	.198

Group I, patients with pleuropericardial window; Group II, patients without pleuropericardial window; ASD, atrial septal defect; CPB, cardiopulmonary bypass; IQR, interquartile range.

RESULTS

There was no difference between the 2 groups with respect to age, height, and weight. Demographic findings are listed in Table 1. The duration of intubation, the duration of ICU stay, and the duration of hospital stay were not significantly different as well.

In accordance to our protocol, postoperative outpatient echocardiographic checks, 1 week and 1 month after discharge were complete for all 45 patients in group I and for 85 patients in group II. Fifteen of 85 patients with no-window developed pericardial effusion while none of the 45 patients with window developed pericardial effusion (P = .001) (Table 2). Clinically significant pericardial effusion was defined as an effusion that was managed with either medical or interventional measures. Effusions that resolved spontaneously were not considered.

Four patients developed mild pericardial effusion but did not require medical or interventional management. These patients were managed as outpatients and called twice a week for frequent echo checks. Effusions resolved spontaneously and did not recur. Ten patients developed more than mild pericardial effusion which required medical treatment. Three had oral prednisolone, and 7 had oral ibuprofen. Effusions were resolved with medications, and they did not have to be hospitalized. These patients were all asymptomatic with no fever and pericardial effusion was detected incidentally on the scheduled check. Pericardial effusion was detected in the second postoperative week in 8 of the 10 patients. The 2 patients' effusion was detected in the fifth postoperative week.

Five patients had to be re-hospitalized because of massive pericardial effusion. These patients were suffering from slight dyspnea on exertion which warranted hospitalization. None of them experienced fever. A pericardiocentesis at the catheter laboratory was done for all, and a pericardial catheter was placed and evacuated daily. Two of these 5 patients were diagnosed to have massive effusion on 1 week check and were hospitalized immediately and pericardiocentesis was done the same day for 1 and the following day for the other. Three patients were found

Table 2. Postoperative Outcome

	Group I n = 45	Group II n = 85	*P*
Pericardial effusion, n (%)	0 (0%)	15 (17.6%)	.001*
Intubation time (days), (mean ± SD)	0.11 ± 0.48	0.05 ± 0.21	.300
ICU stay (days), (mean ± SD)	1.22 ± 0.67	1.22 ± 0.76	.992
LOS of hospital (days), (mean ± SD)	3.60 ± 0.96	3.77 ± 1.56	.491

*Statistically significant parameter.
Group I, patients with pleuropericardial window; Group II, patients without pleuropericardial window; ICU, intensive care unit; LOS, length of stay.

to have effusion on 1 month check. One of them had pericardiocentesis immediately. The other 2 patients were on oral prednisolone initially but showed progression despite the medical treatment, and pericardiocentesis was done 3 days later.

No late-onset pericardial effusion was noted beyond 1 month in any patient in either group. No recurrence was noted for the ones who had experienced an episode of effusion.

DISCUSSION

Pericardial effusion is an eminent complication after cardiac surgery. It is by far the most common postoperative complication after surgical ASD closure for our experience as other groups. In a recent study by Galante et al[2] which was conducted on pediatric patients who underwent open-heart surgery, closure of ASD carried the highest incidence of postoperative pericardial effusion (42%). Preventive measures are important for pericardial effusion, since this condition has a potential of progress to cardiac tamponade and death, if not, causing long rehabilitation hospital stay and readmissions. Medical measures for the prevention of pericardial effusion are controversial. Preventive strategies with medications such as acetylsalicylic acid and other NSAID's, corticosteroids, and colchicine have been studied but found to be inconclusive except for colchicine.[3] In a recent meta-analysis, colchicine was found to be effective in reducing the risk of PPS as well as the re-hospitalization rate after PPS, it was not associated with a significant reduction of postoperative pericardial effusion.[4] However, 2 randomized controlled studies by Meurin conclude that neither NSAID's nor colchicine is effective in reducing pericardial effusion and preventing the development of late cardiac tamponade.[5,6]

In our daily practice, parents of every patient who had surgery for congenital heart diseases are informed to get alert in the presence of any unexpected symptoms like fever, shortness of breath, or problems with the surgical wound. They are also checked with echocardiography for pericardial and pleural effusions before discharge, 1 week after discharge, 1 month after discharge as a part of the protocol. Galante also demonstrates a surge in a number of patients with pericardial effusion on 8 postoperative days.[2] These assessments are done in our clinic whenever possible and are referred to local centers otherwise.

There are no standard diagnostic criteria for PPS, yet the presence of 2 of the followings is accepted to address PPS: fever beyond 1 week after surgery with no other cause, pleuritic chest pain, pericardial friction rub, and presence of pericardial or pleural effusion as stated in the review by Imazio.[7] These criteria which are mainly defined for adult patients are not always easy to detect in a pediatric population. The target is always a demonstration of pericardial effusion by echocardiography, since a relation between pericardial effusion and elevated white blood cell count as well as other inflammatory markers is barely seen.[2] Fifteen of our patients developed pericardial effusion as stated above and in 10 of these patients who expressed no findings, effusion was detected with echo incidentally. One-third of our patients had dyspnea as the only symptom and had to be hospitalized. For this reason, it is important to check all pediatric cardiac patients with echocardiography during the postoperative follow-up.

A retrospective analysis of a large database between 2003 and 2014 by Elias et al[8] stated that 1.1% of 142 633 surgical admissions were re-hospitalized after congenital cardiac surgery, a figure which was accepted as underestimated by the authors of the study. Atrial septal defect closure together with heart transplantation and systemic to pulmonary shunts appeared to be independent risk factors for readmission.[8] A recent Dutch study reports the incidence of postoperative clinically relevant pericardial effusion as 11% in 1241 unclassified surgical episodes in 1031 patients. Older age at surgery, higher body surface area, cardiopulmonary bypass use, and longer duration of mechanical ventilation was found to be risk factors for the development of pericardial effusion. A previous operation was found to have a preventive effect, while right-sided cardiac lesions were increasing the risk.[9] In our cohort, 17% of no-window patients developed relevant pericardial effusion.

Acetylsalicylic acid, ibuprofen, indomethacin, prednisone, and colchicine are generally listed in order as the medical treatment of PPS.[7] In symptomatic patients and in cases if persistence or progression of effusion is noted despite medical treatment, either percutaneous or surgical drainage should be considered.[1] Percutaneous pericardiocentesis under the guidance of echocardiography or fluoroscopy is a feasible method with a complication rate of 1-1.5% in many series.[10] Pericardiodesis can be carefully considered for persistent or recurrent cases but with no strong scientific evidence. Pericardiectomy or pericardial window which is a less invasive surgical method should be considered in recurrent pericardial effusion especially if biopsy material is required.[10] Our treatment protocol consists of NSAID's such as ibuprofen as the first-line drug, followed by corticosteroids in persistent cases. An increase in pericardial effusion despite medical treatment or findings of hemodynamic instability warrants evacuation of the effusion either by percutaneous measures or by surgery.

As a matter of fact, a method that can prevent the development of postoperative pericardial effusion is more important than any measure which is used to treat it. The Pleuropericardial window is a well-known surgical method for the persistent or recurrent pericardial effusion of any kind. Especially patients with malignant effusion and patients with systemic inflammatory disorders are effectively palliated with this well-known technique for a long time. A thoracoscopic intervention is generally preferred for both diagnosis and treatment.[11,12] A left-sided intervention is usually preferred unless right pleural effusion is accompanying the condition.

The publications about the pericardial window are almost exclusively related to the treatment of persistent or recurrent

pericardial effusions. Creation of a pleuropericardial window in order to prevent the development of pericardial effusion thus pericardial tamponade has been rarely emphasized and has been reported by a few authors in the adult cardiac surgery group.[13,14] A left-sided posterior pleuropericardial communication was defined in these reports which are mostly covering heart transplantation, coronary artery bypass surgery, and valvular heart surgery. These reports all conclude that posterior pericardiotomy effectively reduces the incidence of late pericardial effusion. However, the role of a pleuropericardial window in the prevention of pericardial effusion in congenital heart surgery is not well documented and it is not a common procedure.

We used a modified way of creating a pleuropericardial window. A hockey stick incision was done parallel and anterior to the right phrenic nerve at the end of the surgery in order to drain excess pericardial fluid into the right pleural cavity. We found that this technique prevented the collection of pericardial effusion in all cases for at least 4 weeks following surgery.

Demographic findings of the 2 groups were not significantly different. It is evident that more patch closures were done in group I than in group II (26.7% vs. 17.6%). This difference was insignificant, however, it resulted in slightly prolonged clamp time and cardiopulmonary bypass (CPB) time in group I. It is not possible to correlate the shorter duration of aortic clamp time and CPB time with the more frequent occurrence of postoperative pericardial effusion in group II.

This simple and easy technique did not prolong the duration of the surgery nor had any adverse effect on early postoperative recovery. Phrenic nerve injury was accepted as a potential complication of the procedure; however, all pericardial incisions were done under the direct vision of the right phrenic nerve on the pleural side. A safe margin was always kept and a functional right diaphragm with echocardiography was noted in all patients. Early postoperative findings, the duration of mechanical ventilation, length of ICU stay, and length of hospital stay were not different in both groups suggesting that no adverse incident was encountered in patients in group I.

The creation of a right pleuropericardial window as a precaution resulted in safe postoperative recovery after surgical ASD closure in all patients. No adverse effect of the creation of a pleural communication was noted. It is now accepted as a routine component of the surgical procedure.

Study Limitations

The objective of this presented study was defined as an evaluation of the relationship between the creation of pleuropericardial windows and the postoperative development of pericardial effusion. Postpericardiotomy syndrome was described as a major incident commonly encountered in 4–6 weeks following surgical closure of ASD. The results are solid and enlighting with respect to this time period. However, long-term results are lacking. Yet, any adverse effect is not anticipated.

CONCLUSION

In conclusion, the right pleuropericardial window is a safe and effective method in preventing the occurrence of pericardial effusion which is an eminent complication after surgical ASD closure, hence, provides secure recovery for all patients.

Ethics Committee Approval: The study was designed as retrospective data analysis therefore ethical committee approval was not warranted.

Informed Consent: Written informed consent about the surgical procedure was obtained from all patients enrolled in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – M.Ö.; Design – M.Ö., D.S.B.; Supervision – M.Ö.; Data Collection – M.Ç., Ç.G.; Analysis – M.Ö., D.S.B.; Literature Review – M.Ç., Ç.G.; Writing – M.Ö., D.S.B.; Critical review – M.Ö.

Acknowledgments: None.

Declaration of Interests: The authors declare that they have no competing interests.

Funding: This study received no funding.

REFERENCES

1. Adler Y, Charron P, Imazio M, et al. 2015. ESC Guidelines for the diagnosis and management of pericardial diseases The Task Force for the Diagnosis and Management of Pericardial Diseases of the European Society of Cardiology (ESC) Endorsed by: the European Association for Cardio-Thoracic Surgery (EACTS) Authors/Task Force. *Eur Heart J*;36(42):2921-2964. [CrossRef]
2. Galante GJ, Schantz DI, Myers KA, Pockett CR, Rebeyka IM, Mackie AS. Echocardiographic screening for postoperative pericardial effusion in children. *Pediatr Cardiol*. 2021;42(7):1531-1538. [CrossRef]
3. Imazio M, Trinchero R, Brucato A, et al. COlchicine for the Prevention of the Postpericardiotomy Syndrome (COPPS): a multicentre, randomized, double-blind, placebo-controlled trial. *Eur Heart J*. 2010;31(22):2749-2754. [CrossRef]
4. Lutschinger LL, Rigopoulos AG, Schlattmann P, et al. Meta-analysis for the value of colchicine for the therapy of pericarditis and of postpericardiotomy syndrome. *BMC Cardiovasc Disord*. 2019;19(1):227. [CrossRef]
5. Meurin P, Tabet JY, Thabut G, et al. Nonsteroidal anti-inflammatory drug treatment for postoperative pericardial effusion: a multicenter randomized, double-blind trial. *Ann Intern Med*. 2010;152(3):137-143. [CrossRef]
6. Meurin P, Lelay-Kubas S, Pierre B, et al. French Society of Cardiology. Colchicine for postoperative pericardial effusion: a multicentre, double-blind, randomized controlled trial. *Heart*. 2015;101(21):1711-1716. [CrossRef]
7. Imazio M. The post-pericardiotomy syndrome. *Curr Opin Pulm Med*. 2012;18(4):366-374. [CrossRef]
8. Elias MD, Glatz AC, O'Connor MJ, et al. Prevalence and risk factors for pericardial effusions requiring readmission after pediatric cardiac surgery. *Pediatr Cardiol*. 2017;38(3):484-494. [CrossRef]
9. Adrichem R, Le Cessie S, Hazekamp MG, et al. Risk of clinically relevant pericardial effusion after pediatric cardiac surgery. *Pediatr Cardiol*. 2019;40(3):585-594. [CrossRef]

10. Imazio M, Adler Y. Management of pericardial effusion. *Eur Heart J*. 2013;34(16):1186-1197. [CrossRef]
11. Cantó A, Guijarro R, Arnau A, et al. Thoracoscopic pericardial fenestration: diagnostic and therapeutic aspects. *Thorax*. 1993;48(11):1178-1180. [CrossRef]
12. Sakanoue I, Hamakawa H, Okubo Y, et al. Efficacy and safety of thoracoscopic pericardial window in patients with pericardial effusions: a single-center case series. *J Cardiothorac Surg*. 2016;11(1):92. [CrossRef]
13. Uzun K, Günaydın ZY, Tataroğlu C, Bektaş O. The preventive role of the posterior pericardial window in the development of late cardiac tamponade following heart valve surgery. *Interact Cardiovasc Thorac Surg*. 2016;22(5):641-646. [CrossRef]
14. Kaya M, İyigün T, Yazıcı P, et al. The effects of posterior pericardiotomy on pericardial effusion, tamponade, and atrial fibrillation after coronary artery surgery. *Kardiochir Torakochirurgia Pol*. 2014;11(2):113-118. [CrossRef]