Research article

Relationship between history of previous surgeries and pericardial involvement in patients undergoing cardiac surgery

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Abstract

Objective: We aimed to define whether timing and multiple surgeries have an impact on development of postpericardiotomy syndrome (PPS) and its complications.

Methods: We retrospectively analyzed clinical and operative data of 40 patients with signs of PPS after cardiac surgery. Among them, 9 patients had signs of effusion (E) only and 31 patients had adhesive/ constrictive/constrictive-effusive (C) pericardial involvement.

Results: Patients in E only group had significantly larger E size (p=0.03), higher white blood cell count (p=0.014) and tendency to higher sedimentation rate (SR) as compared to C group. We found significantly longer period of hospital stay (p=0.042), higher number of redo surgeries (1.33(0.88) vs 0.67(0.50), p=0.008) and longer time past since latest surgery (102.91(97.49) vs. 0.14(0.38) months, p<0.0001) in patients with C as compared to patients with E. Correlation analysis demonstrated positive correlation between E amount and SR (r=0.66, p0.008), and its negative correlation with number of reoperations (r=-0.83, p=-0.0001) and time related to operation (r=-0.69, p=0.001); while thickening of pericardium was related positively with C-reactive protein (r=0.59, p=0.026), and time related to operation (r=0.51, p=0.004). In our small preliminary selected series of patients undergoing cardiac surgery, PPS was complicated by signs of tamponade in 2.5% of patients and constriction in 7.5%.

Conclusion: Thus, postpericardiotomy effusions are associated with the shorter time from surgery and less number of redo-surgeries, and inflammation, while adhesive pericardial involvement more often develops in patients with longer period after surgery and thickening of pericardium is positively associated with increase of C-reactive protein levels and time related to operation.

Key words: pericardial effusion, constriction, cardiac surgery procedures

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Introduction

Postpericardiotomy syndrome (PPS) develops in 1/3 of patients after cardiac surgery: coronary artery bypass, valvular heart disease (VHD), aorta and congenital heart disease surgeries (1-6). PPS is defined in presence of at least 2 following criteria: 1) fever occurring at least one week after surgery without underlying infection 2) pleuritic pain; 3) pericardial rub 4) pleural effusion and 5) pericardial effusion and tamponade requiring intervention (1). Tamponade and constrictive pericarditis are the main complications of PPS after cardiac surgery (1-6). Several factors are thought to play a role in development of effusion and constriction after cardiac surgery including inflammation, pericardial injury and operative technique (7-10). Repeated mechanical and chemical pericardial injury in patients undergoing multiple cardiac operations may potentially contribute to development of fibrosis and adhesions of pericardium, however few is known on the relation between history of redo-surgery and pericardial involvement.

We aimed to define whether timing and multiple surgeries have an impact on development of PPS.

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Methods

Patients and study design

We retrospectively analyzed data of 500 patients who underwent heart surgery at our surgery center. Among them 40 patients had signs of pericardial involvement: effusion – 9 patients (effusion group) and adhesive (adhesive and adhesive-effusive)/constrictive (constrictive, constrictive-effusive) - 31 patients (adhesion/constriction group). The effusion and thickening/adhesions/ calcifications of pericardium were documented by echocardiography or intra-operatively. All the patients gave informed consent before procedures

Data analysis

We included in analyses baseline demographic (age, sex), clinical (NYHA class, duration of hospitalization, heart rate, blood pressure, central venous pressure, cardiothoracic index by X-ray), laboratory (hemoglobin, hematocrit, total blood count, sedimentation rate, C-reactive protein, glucose levels), electrocardiographic (presence of atrial fibrillation, QRS alternans and low QRS voltage), echocardiographic (left atrial and left ventricular size, right ventricular size, left ventricular ejection fraction, mean pulmonary arterial pressure, effusion size and localization, pericardial thickening) and intraoperative/ intervention (adhesions and calcifications of pericardium, type of pericardial involvement: effusion, effusion with compression (tamponade), adhesions, adhesions with effusion, constriction/ constriction with effusion, effusion size and extent by echo and drainage, type of treatment: variables, as well as number of and time past since previous cardiac surgeries. The evaluation of constriction and effusion was done during operation/surgery and perioperatively by echocardiography. During operation the pericardial sac was evaluated for presence of adhesions – areas of soldered epicardium and pericardium, obliteration. Revision included all intrapericardial areas anterior, lateral, posterior and inferior, left and right atrial surfaces and great vessels surfaces. We did not provide information on grading of adhesions in this study, but we used the grading proposed by Mitchell et al. (11): Grade 0 indicates - no adhesions; grade I adhesions are filmy, light, and transparent, with minimal fibrous stranding; grade 2 adhesions - continuous, but avascular, and could be taken down by blunt dissection; grade 3 adhesions are more significant, with some vascularity, and required sharp dissection; and grade 4 adhesions are dense, marked by obliteration of tissue planes.

We used interrupted suture technique during closure of pericardium, flashing with saline and drainage to prevent spill of blood, formation of effusion, and adhesions.

Statistical analysis

Statistical analysis was performed using SPSS 19 for Windows software (IBM, NY). Categorical variables were compared using Chi-square test and continuous variables using unpaired t-test after testing for normality of distribution. Correlation analysis was performed using Pearson correlation test.

Results

Our study demonstrated (Table 1) that both groups of patients did not differ by age, sex, NYHA class, heart rate and blood pressure and central venous pressure. We found significantly longer period of hospital stay (p=0.042) in patients with A/C as compared to patients with effusion. Patients with effusion had significantly higher white blood cell count (p=0.014) and lower glucose levels (p=0.045). Analysis of ECG revealed low voltage QRS in 2 patients in each group and QRS alternans in 1 patient in effusion group, while atrial fibrillation was recorded in 1/3 of patients with effusion and more than ½ half of patients with constriction. There were no differences in cardiac chambers` size, mean pulmonary arterial pressure and left ventricular ejection fraction between groups. However, we recorded significantly larger effusion size by echocardiography in patients with effusion (p=0.036). In adhesion/constriction group effusion was localized and confined to left ventricular posterior wall.

Table 1. Clinical characteristics of patients with pericardial involvement after cardiac surgery

Variables	**Effusion (n=9)**	**Adhesion/Constriction w/wo effusion (31)**	**p**
Age, years	47.7 (11.7)	43.7 (14.3)	NS
Sex, n(%) Female Male	 7 (77.8) 2 (22.2)	 23 (74.2) 8 (25.8)	NS
NYHA class	3.0 (0.5)	3.1 (0.5)	NS
Duration of hospitalization	13.9 (8.1)	21.0 (9.1)	0.042
Echo effusion, size, cm	3.08 (1.62)	1.14 (1.12)	0.036
Mean PAP, mm Hg	41.7 (14.9)	44.5 (14.0)	NS
LA, mm	46.2 (9.7)	44.7 (10.5)	NS
LVEDD, mm	50.2 (6.2)	47.9 (7.3)	NS
LVESD, mm	33.3 (3.1)	30.1 (7.2)	0.073
LVEF, %	61.0 (4.2)	64.4 (8.3)	0.06
RV, mm	18.3 (9.1)	23.8 (6.7)	0.068
CVP, mm	92.5 (59.0)	101.0 (48.1)	NS
HR, bpm	85.2 (11.4)	86.7 (20.5)	NS
SBP, mmHg	110.6 (25.2)	113.7 (18.1)	NS
DBP, mmHg	67.5 (15.1)	67.8 (14.0)	NS
C-reactive protein, mg/dL	6.0 (5.8)	7.14 (3.9)	NS
HB, mg/dL	119.3 (24.8)	122.6 (23.9)	NS
Ht, %	34.2 (9.5)	36.8 (7.4)	NS
RBC, $x10^{12}$	4.0 (0.5)	4.13 (0.7)	NS
WBC, $X10^{9}$	9.3 (6.6)	5.9 (1.6)	0.014
SR, mm/h	15.25 (12.62)	12.56 (11.91)	NS
Glucose, mmol/l	2.85 (1.06)	6.39 (3.45)	0.045
AF, %	3 (33.3)	17 (54.8)	NS
Low QRS voltage ECG, n(%)	2 (22.2)	2 (6.4)	NS
QRS alternans, n(%)	1 (11.1)	0 (0)	NS
CTI, n(%)	66.4 (15.2)	61.1 (10.2)	NS
Re-hospitalization, n(%)	0(0)	3 (9.7)	NS

AF – atrial fibrillation, CTI – cardiothoracic index, CVP – central venous pressure, DBP- diastolic blood pressure, ECG – electrocardiography, Echo – echocardiographic, HB- hemoglobin, HR – heart rate, Ht- hematocrit, LA- left atrium, LV EDD- left ventricular end- diastolic dimension, LV EF – left ventricular ejection fraction, LV ESD – left ventricular end-systolic dimension, PAP – pulmonary arterial pressure, NS – nonsignificant, NYHA – New York Heart Association, RBC – red blood cell count, SBP – systolic blood pressure, SR – sedimentation rate, w/wo – with/without, WBC – white blood cell count

Table 2. History of surgery and peri-operative variables			
Variables	**Effusion (n=9)**	**Constriction w/wo effusion (n=31)**	**p**
History of surgery, n(%)			
No history of previous surgery	3 (33.3)	7 (22.5)	NS
MVR	1 (11.1)	13 (43.3)	
AVR	0	2 (6.7)	
MVR+AVR	0	2 (6.7)	
MVR+AVR+TV repair	1 (11.1)	2 (6.7)	
MVR+TV repair	1(11.1)	1 (3.3)	
MV repair	2 (22.2)	1 (3.3)	
MVR, LA thrombectomy	0	1 (3.3)	
MV para-prosthetic fistula repair(TV repair	0	1 (3.3)	
Tumors	1 (11.1)	1 (3.3)	
Reoperations, n	0.67 (0.50)	1.33 (0.88)	0.008
Time from operation, months	0.14 (0.38)	102.91 (97.49)	<0.0001
Pleural effusion	1 (12.5)	5 (17.9)	NS
Pericardial effusion	9 (100)	16 (51.6)	0.009
Pericardial involvement, n(%)			
Effusion	8 (88.9)	0 (0)	<0.0001
Tamponade	1 (11.1)	0 (0)	
Constriction	0 (0)	1 (3.2)	
Constrictive-effusive	0 (0)	2 (6.5)	
Adhesive	0 (0)	20 (64.5)	
Adhesive- Effusive	0 (0)	8 (25.8)	
Large effusion by echo/intervention, n(%)			
Large localized >10mm/>100 ml	0 (0)	2 (6.5)	NS
Large diffuse, >20mm/> 400ml	4 (44.4)	1 (3.2)	NS
Effusion size, ml	809.4 (1331.2)	71.3 (157.1)	0.04
Thickening of pericardium, mm	0	0.95 (0.21)	<0.0001
Adhesions&Calcification of pericardium, n(%)			
Adhesions	0 (0)	28 (90.3)	<0.0001
Calcifications	0 (0)	3 (9.7)	
AVR – aortic valve replacement, LA – left atrium, MV – mitral valve, MVR – mitral valve replacement, TV – tricuspid valve, w – with, wo – without			

Operative characteristics (Table 2) showed no difference in history of types of surgery, majority underwent valvular heart surgery. Patients with constriction had higher number of redo surgeries ($p<0.0001$) and longer time related to latest surgery in patients with signs of constriction (102.91 (97.49) months vs. 0.14 (0.38) months, $p=0.008$) as compared to patients with effusion. There were no differences in frequency of pleural effusion, though pericardial effusion was recorded in all patients in effusion group and 51.6% of constriction group ($p=0.009$), the effusion in the latter group was localized. The groups did not differ by extent of localized and diffuse effusions classified as large by intervention/echocardiography.

Adhesions of varying density were revealed in 28 patients and calcifications with grade 3-4 adhesions in 3 patients in adhesions/constriction group and the mean pericardial thickening was equal to 0.95 mm. Tamponade was recorded in 1 patient and effusions of different size in 8 patients in effusion group. Constriction was revealed in 3 patients in adhesion/constriction group (1 constrictive pericarditis and 2 constrictive-effusive), adhesions of varying density in 20 patients and adhesive-effusive involvement in 8 patients. No adhesions were revealed intraoperatively in patients with effusion.

Majority of patients in effusion group underwent medical therapy with non-steroidal anti-inflammatory agents and pericardiocentesis, and none required emergency re-operation due to pericardial effusion; while in adhesion/constriction group 1 patient underwent pericardiocentesis due to large effusion, 2 patients with constrictive-effusive pericarditis showed improvement on medical therapy and 1 patient with constrictive pericarditis underwent pericardioectomy during re-hospitalization, intervention on pericardium with dissection of adhesions was performed in 27 patients during redo-operation for valvular heart disease. Unfavorable outcomes – re-hospitalizations due to recurrent pericardial disease were recorded only in adhesions/constriction group in 3 patients, there was no cases of mortality.

Correlation analysis demonstrated presence of positive correlation of effusion amount and SR ($r=0.66$, $p=0.008$), its negative correlation with number of reoperations ($r=-0.83$, $p=-0.0001$) and time related to operation ($r=-0.69$, $p=0.001$); while thickening of pericardium was related positively with C-reactive protein ($r=0.59$, $p=0.026$), and time related to operation ($r=0.51$, $p=0.004$).

Discussion

Our study demonstrated that of 40 patients undergoing cardiac surgery - 22.5% had effusion and 77.5% - predominantly adhesive/constrictive involvement. Patients with effusion have significantly shorter time past since last surgery and less redo operations, while patients with adhesion/constriction had longer time after pervious surgery and more redo operations. Correlation analysis showed that effusion was associated with inflammation and develops early after operations in patients with fewer redo surgeries. On the other hand, adhesive/ constrictive PPS tended to develop late after surgery and pericardial thickening was associated with higher levels of C-reactive protein.

Several mechanisms for PPS development were reported including injury during operation, operative technique, pericardium and bleeding, chemical and cold injury aggravated by drying procedures, inflammation and loss of proteoglycan 4 activity (7-10, 12). All these mechanisms might have contributed to development of PPS with constriction in our patients. We have to note the operative technique and protocol was standard in all patients; we close pericardium with sutures and leave the window for drainage and used saline to flash pericardial cavity. Constriction was recorded only in 3 patients, while in all other cases the involvement was predominantly adhesive. Our results confirm previous investigations on the contribution of inflammation (7-10) in the development of PPS, specifically higher count of leucocytes and relation of amount of effusion with sedimentation rate in effusion only group and positive relation of pericardial thickening with C-reactive protein.

We extended previous investigations by showing potential role of timing factor and number of previous redo surgeries in the development of PPS with adhesive/constrictive pattern developed late after usually multiple surgeries and effusive only - early after surgery with fewer previous redo surgeries.

It has been suggested that effusions develop almost in all patients undergoing cardiac surgery and PPS with effusion is as sign of failed resorbtion (10) and adhesions observed in every 6th patient undergoing redo-surgery. We can assume that repeated pericardial injury during redo surgeries along with inflammation can contribute to development of adhesions/ constriction and effusions.

Complications of PPS in our patients were close to reported in literature- tamponade 2.5% and constriction 7.5% (2-5, 13, 14), which were treated successfully. We have to acknowledge that majority of our patients underwent valvular heart surgery and we did not have patients undergoing coronary bypass surgery. Whether type of surgery accounts for differences in rate of outcomes need to be clarified.

We performed analysis of effusions and adhesions/calcifications documented by imaging and intraoperatively in patients undergoing cardiac surgery and found that timing and number of redo-surgeries and inflammation may play role in the development of either effusion or adhesions/constriction. Further studies on larger number of patients should be undertaken to clarify which patient with adhesions/calcifications is at risk of development of constrictive pericarditis.

Prevention of postpericardiotomy syndrome and its complications may include use of interrupted sutures, drainage, avoid chemical or cold exposure, as use of colchicine after surgery (15).

Study limitations

We have to emphasize the limitations of the study as small sample size and retrospective nature of the study. Further studies on larger number of patients are needed to clarify predictors of PPS development, prognostic significance and outcomes of interventional treatment of PPS complicated with constriction and effusion.

Conclusion

Thus, our preliminary data suggests that postpericardiotomy effusions are tended to be associated with the shorter time from surgery and less number of redo-surgeries, and inflammation, while adhesive pericardial involvement more often develops in patients with longer period after surgery and thickening of pericardium is positively associated with increase of C-reactive protein levels. In our small preliminary selected series of patients undergoing cardiac surgery, postpericardiotomy syndrome was complicated by signs of tamponade in 2.5% of patients and constriction in 7.5%. The re-hospitalizations rate was 7.5%.

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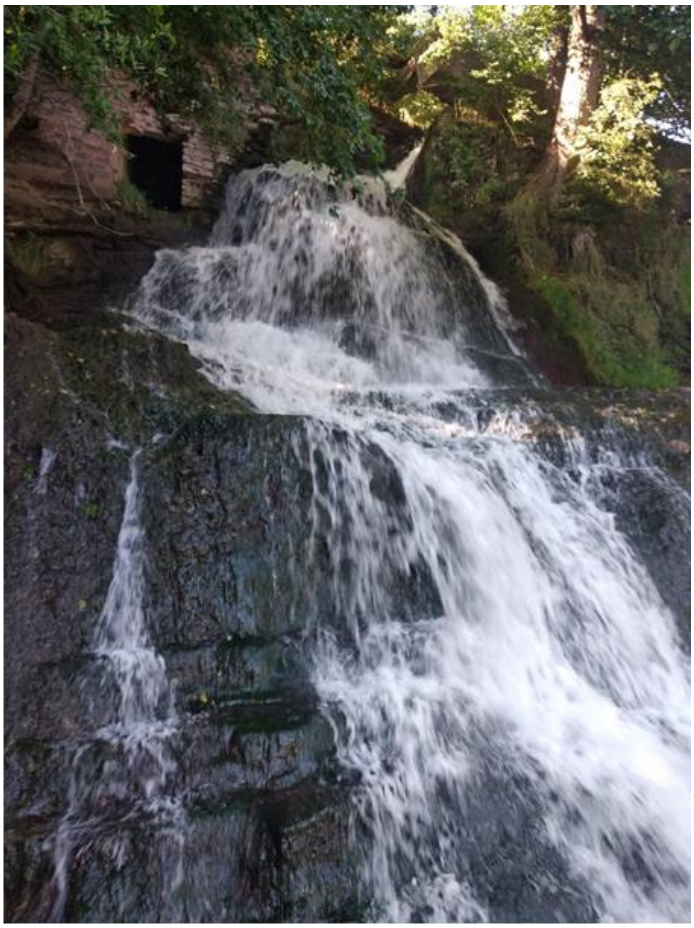

Dzhurn waterfall, near Dnister river, Western Ukraine - summer 2020. Mykhaylo Sorokivskyy, Lviv, Ukraine