



Should Plication or Graft be used in Pulmonary Artery Aneurysm operations?

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Objective: Pulmonary artery aneurysms (PAA) are rare diseases generally diagnosed coincidentally. Although most of the PAA patients are asymptomatic, they can be symptomatic due to complications such as rupture, pulmonary valve leakage, thromboemboli, dissection and pressure on coronary arteries and pulmonary valve. Our aim in this study was to compare plication and graft usage techniques in PAA operations. **Material and Method:** A total of 11 patients who had elective PAA operation between January 1, 2010 and December 31, 2018 in our clinic and had registered demographical information were retrospectively examined. Patients included in the study were separated into two groups as those who had plication in PAA (Group 1) and those who had tube graft change in PAA (Group 2). There were six patients in Group 1 (2 F, 4 M) and five patients (2 F, 3 M) in Group 2. Preoperative and postoperative data of the patients in both groups were registered and examined in detail. **Findings:** Among the 11 patients who had surgical repair due to PAA, seven were male and four were female. Although the ages of the patients changed between 38 and 65, the average age was 53.4 years. There was no significant difference in diabetes mellitus, hypertension, coronary artery disease among the groups. Chronic obstructive pulmonary disease (COPD) was observed more in Group 1. Operations were made under cardiopulmonary bypass. Aortic cross clamp duration (ACC) was 96 ± 18 minutes in Group 1 and 105 ± 22 minutes in Group 2 ($p > 0.05$). Average intensive care unit hospitalization duration of the patients was 2.5 ± 1.5 days in Group 1 and 3.4 ± 1.5 days in Group 2 ($p < 0.05$) but no statistically significant difference was found among the average hospitalization durations of the patients ($p > 0.05$). **Result:** Although observed frequently, PAA can cause mortality especially due to causes such as rupture and dissection. Surgical intervention is required in patients with PAA over 5,5 cm. Although different views are available in literature, in our study, we detected tube graft usage to be more effective in surgical treatment. As there is a change of aneurysm reformation in postoperative follow-ups of the patients who had plication especially, we suggest graft usage in PAA surgical treatment.

INTRODUCTION

Pulmonary artery diameter of 4 cm and above is defined as PAA (1). Pulmonary arteries continue as the main pulmonary artery based on the right ventricular outflow tract and then they are separated into two parts as right and left pulmonary arteries. While left pulmonary artery directly leads to the lung, right pulmonary artery reaches the lung after passing aorta.

Isolated PAA is rare. Many factors are blamed in PAA etiology. Diseases causing pulmonary hypertension (PAH), atherosclerosis, connective tissue diseases, trauma, dissection, infection diseases and congenital cardiac diseases are among the main causes. Cardiac valve disorders, COPD, sarcoidosis, occupational diseases, asthma and idiopathic PAH can be named among diseases causing pulmonary hypertension. PAA can be seen especially in Marfan and Ehler Danlos Syndromes among connective tissue diseases and in Behcet's disease (2) among autoimmune diseases. PAA can be observed in the final stage of syphilis among infection disease, in bacterial endocardites and tuberculosis. The ratio was reported as 1 in 14000 mortalities in autopsy

series (3).

Although this disease doesn't have a specific symptom, PAA patients can be symptomatic due to its complications. Effort dyspnea, cough, fistulation of pulmonary artery to trachea and hemoptysis and most frequently chest pain can be named among the symptoms observed. The most important and severely life-threatening complications of PAA are rupture and dissection. 11 PAA patients operated in our clinic were retrospectively examined in this study. Plication was made for some of the patients and tube graft replacement was made after aneurysm excision for the others and the two groups were examined by comparing.

FINDINGS

A total of 11 patients were included in the study. Seven of the patients were male and four were female. Although the ages of the patients changed between 38 and 65, the average age was 53.4 years. Patients studied were separated into two groups as those who had plication in PAA (Group I) and those who had tube graft change in PAA (Group II). There were six patients in Group 1 (2 F, 4 M) and five patients (2 F, 3 M) in Group 2. The average age was 53.8 in Group 1 and 53 in Group 2. Preoperative demographical data of the patients are shown in Table I. The most common symptom of the patients was dyspnea. Four patients were smokers, two patients had DM, three patients had COPD and two patients had HT in Group 1. Three patients were smokers, one patient

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had DM and three patients had HT in Group 2. Two patients had mitral stenosis (MS) and two patients had atrial septal defect (ASD) in Group 1 and one patient had MD and three patients had ASD in Group 2. Isolated PAA was present in two patients in Group 1 and one patient in Group 2. There was no significant difference among the two groups in DM, hypertension, hypercholesterolemia and smoking according to the statistical examination made ($p>0.05$).

Mean pulmonary artery diameter of the patients was 57 ± 1.4 cm in Group 1 and 58 ± 1.6 cm in Group 2. Pulmonary arterial pressure measured ecocardiographically was 45 ± 15 , in Group 1 and 50 ± 15 mmHg in Group 2. No pulmonary valve intervention was required during the operation in both groups. ACC duration was 96 ± 18 in Group 1 and 105 ± 22 minutes in Group 2 and was not statistically significant ($p>0.05$). Intraoperative findings are available in Table 2. Blood and blood products given to the patients during operation was 2.1 ± 0.9 U in Group 1 and 2.2 ± 1.1 U in Group 2 ($p>0.05$). One patient in Group 2 was taken in revision due to bleeding. There was no statistically significant difference among the two groups in inotropic agent use. Blood and blood products given postoperatively to the patients was 2.1 ± 0.5 U in Group 1 and 3.5 ± 1.4 U in Group 2 ($p>0.05$). Shorter intubation and intensive care unit hospitalization durations were observed in the patients in Group 1 compared to Group 2 patients and this was statistically significant ($p<0.05$). But the average hospitalization duration of the patients was 8.4 ± 1.3 days in Group 1 and 9.7 ± 1.1 days in Group 2 and was not statistically significant ($p>0.05$). Postoperative pneumonia occurred in one patient in both groups and was taken under control with suitable antibiotic treatment.

Mortality was observed in one patient in Group 1. Right cardiac failure was the detected cause. In the postoperative control ecocardiography, it was observed in the postoperative control ecocardiography that main pulmonary artery aneurysm re-occurred in two patients in Group 1 in a year. Patients were followed-up.

DISCUSSION

Pulmonary artery aneurysm (PAA) is a rare congenital or acquired pathology (4). Its prevalence was reported as 1 in 14,000 mortalities in autopsy series (5). Congenital cardiac diseases, connective tissue diseases, infections such as syphilis and tuberculosis, vasculitides, neoplasias, primary or secondary pulmonary hypertension, idiopathic or iatrogenic causes, pulmonary artery dissection and pulmonary emboli were reported in PAA etiologies (3). Trauma and pulmonary valve stenosis are also included in PAA etiology (6). Main pulmonary artery wider than 4 cm or pulmonary artery diameter widened 1.5 times the normal value is called PAA (7). It was reported that 89% of PAA are in main pulmonary artery and 11% involves pulmonary artery branches (8). Reisenauer et al (9) called pulmonary artery aneurysms between 5-8 cm wide aneurysms and those wider than 8 cm as giant aneurysm.

The importance of cystic medial degeneration in PAA histology was emphasized (10). It was also stated that type 4 prostaglandin E receptors reported to play role in abdominal aorta aneurysms (11) could cause pulmonary artery aneurysm especially in pulmonary hypertensive patients (12). It was demonstrated that matrix metalloproteinase-2 was activated through the stimulation of Type 4 prostaglandin E receptors and thus the formation of a local inflammation was detected in artery wall (13). It is considered that Type 4 prostaglandin E receptor antagonists can be advantageous in the follow-up of PAA patients. TNF alpha inhibitors were reported to be active in the treatment of PAA patients who have Behcet's disease which is among the vasculitides mentioned in PAA etiology (14). PAA widening can cause local

pressure and can be symptomatic (15). Dyspnea, cough, chest ache or hoarseness can be observed (10). The most common symptom was dyspnea in our patients.

PAA can be discovered by coincidence after the controls made for different causes. Ecocardiography which is an invasive method should primarily be used for diagnosis. Contrast computed tomography and magnetic resonance angiography can be done when suspected. But pulmonary angiography is the golden standard in PAA diagnosis (16). Attention should be paid to pulmonary hypertension in the follow-ups of PAA-diagnosed patients. Duijnhouwer et al. (7) stated that high pressure pulmonary artery aneurysms could be related to congenital cardiac diseases or idiopathic causes and low pressure pulmonary artery aneurysms could be related to causes such as connective tissue disease, poststenotic dilatation or pulmonary valve deficiency. A lower dissection risk was reported in low pressure pulmonary artery aneurysms compared to the high pressurized (17).

It was also demonstrated that pulmonary artery pressure could also increase in line with pulmonary artery diameter expansion. 51 patients were examined in a study by Boerrigter et al (18) and it was stated that pulmonary arterial dilatation was useful in the follow-up of pulmonary hypertensive patients. 5.5 cm safety limit reported for ascending aorta aneurysms in literature is not clarified for PAA. Lopez- Candales et al (19) reported the occurrence of pulmonary arterial dissection in a 6 x 5.5 cm PAA case. In a study by Zylkowska et al (20), it was reported that left main coronary artery pressure prevalence increased when PAA diameter is over 5,5 cm. In the same study examining 264 patients, it was stated that unexpected and sudden cardiac death risk increased 7.5 times when pulmonary artery diameter is over 4,8 cm. It was reported that PAA diameter over 6 cm could be related to atelectasis following lung pressure or thrombosis in right pulmonary artery (21). It was reported that pulmonary artery dissection occurred rarely when PAA diameter is below 7,5 cm and the pulmonary artery pressure is under 50 mmHg but there are also studies focusing on the necessity of surgical repair in PAAs over 6 cm (7).

Different surgical repair strategies were reported for PAA. Pulmonary artery aneurysm plication, repair with pericardial patch and repair with graft interposition stand out among these (22). In literature, PAA plication is described as a practical and fast approach due to its fast and easy application (16). But it was stated that PAA could relapse after this plication surgery. Four patients were examined in a study by Kuwaki et al (23) and PAA was intervened by using dacron graft in two patients and through plication in two patients. As PAA relapsed in one of the patients who had plication, the patient was re-operated using dacron graft. There are studies reporting that graft interposition provides a certain repair (24). But there are also publications reporting that repair methods through pulmonary artery aneurysm plication or graft interposition are equally effective. In a study by Deb et al (10), five patients were retrospectively examined and it was stated that there was no difference in mortality and long-term follow-ups following both operation techniques.

We applied plication in six patients in Group 1 and tube graft interposition in five patients in Group 2 in our study including 11 patients who had surgical repair due to PAA. We observed that the surgical methods in both groups are safely applicable. But after PAA plication, we detected relapse of aneurysm formation in a year in the control ecocardiography in two patients. Although the patient number was limited in the retrospective study we made, we recommend the use of graft position we observed as a permanent repair method in surgical treatment of PAA patients.

Table 1 Preoperative Patient Data

Variable	Group 1(n=6)	Group 2(n=5)	pvalue
Average Age (Year)	53.8	53	p>0.05
Sex (Male / Female)	4M/2F	3M/2F	p>0.05
Average BMI	21.4 ± 2.6	25.4 ± 3.5	p>0.05
EF (%)	45 ± 10	50 ± 10	p>0.05
PulmonaryArteryDiameter (cm)	57±1.4	58±1.6	p>0.05
PulmonaryArteryPressure (mmHg)	45 ± 15	50 ± 15	p>0.05
HT	2 (%18.1)	2 (%18.1)	p>0.05
DM	2 (%18.1)	1 (%9)	p>0.05
COPD	3 (%27.2)	1(%9)	p>0.05
PreoperativeCreatinine	1.2 ±0.4	1.1 ± 0.3	p>0.05
Preoperative Hg levels (gr / dl)	14 ± 1.5	15± 2.5	p>0.05
Preoperative INR	1.2 ± 0.2	1.1 ± 0.5	p>0.05
PreoperativePlateletlevels	270.000 ± 25.000	280.000 ± 35.000	p>0.05
Mitral Stenosis	2 (%18.1)	1 (%9)	p>0.05
AtrialSeptalDefect	2 (%18.1)	3 (%27.2)	p>0.05
Isolated PAA	2 (%18.1)	1 (%9)	p>0.05
EUROSCORE	4.53 ± 1.83	3.72 ± 1.32	p>0.05

Table 2 Operation Data

Variable	Group 1(n=6)	Group 2(n=5)	pvalue
Total CPB Time (minutes)	113 ± 15	125 ± 20	p>0.05
Cross-clamp Time (minutes)	96 ± 18	105 ± 22	p>0.05
Theamount of bloodproductsusedduringtheoperation (Units)	1.1 ±0.9	1.2 ± 1.1	p>0.05
Inotropic Agent Use (%)	4 (%36.3)	3 (%27.2)	p>0.05

Table 3 PostoperativePatient Information

Variable	Group 1(n=6)	Group 2(n=5)	pvalue
Entubation Time (hour)	5.2 ± 2.4	6.5 ± 3.5	p<0.05
Total drainage (ml)	600 ±155	950 ± 350	p<0.05
Postoperativeblooduse (unit)	2.1 ± 0.5	3.5 ± 1.4	p>0.05
Hg levels (gr / dl)	9.4 ± 3.1	8.1 ± 2.0	p>0.05
AtrialFibrillation	4 (%36)	3 (%27)	p>0.05
Total ICU Stay (days)	2.5 ± 1.5	3.4 ± 1.5	p<0.05
Pneumoniaincidence(%)	1 (%9)	1 (%9)	p>0.05
Duration of Hospitalization (days)	8.4 ± 1.3	9.7 ± 1.1	p>0.05

**Figure 1**

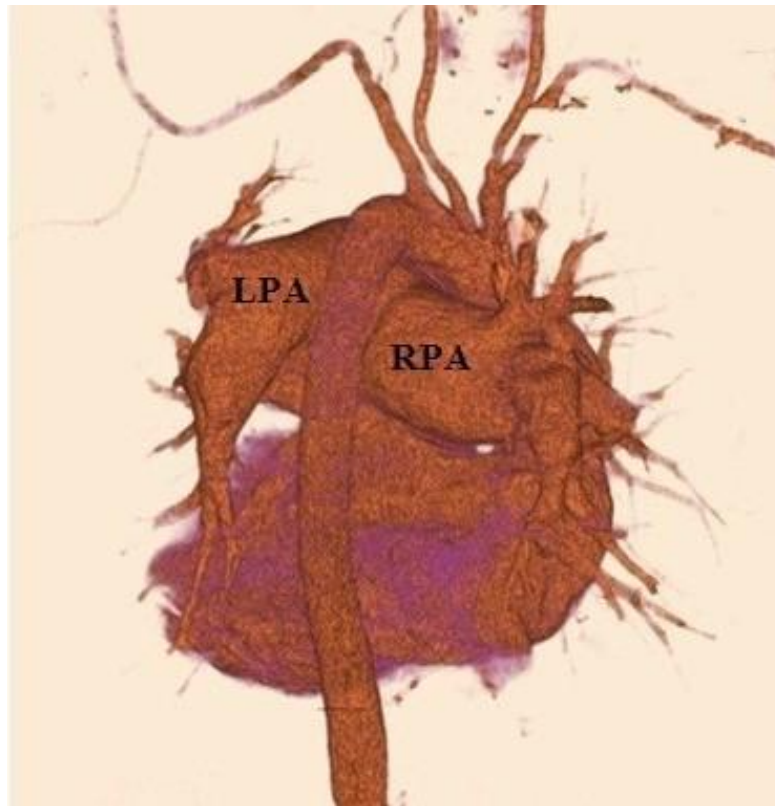


Figure 2

CONCLUSION

Although observed frequently, PAA can cause mortality especially due to causes such as rupture and dissection. Surgical intervention is required in patients with PAA over 5,5 cm. Although different views are available in literature, in our study, we detected tube graft usage to be more effective in surgical treatment. As there is a change of aneurysm reformation in postoperative follow-ups of the patients who had plication especially, we suggest graft usage in PAA surgical treatment.

MATERIAL - METHOD

Among a total of 10.372 open cardiac surgeries electively made in our clinic between January 1, 2010 and December 31, 2018, a total of 11 patients who were operative for PAA and whose demographical information were recorded were retrospectively examined.

Additional diseases and risk factors of the patients such as COPD, hypertension (HT), diabetes mellitus (DM), pulmonary hypertension, smoking, hypercholesterolemia were registered and examined before the operation. EUROSCORE was used for pre-operation risk scoring of all patients. Preoperative and postoperative data of the patients in both groups were registered and examined. With preoperative ecocardiography, valve pathologies, ventricle functions, pulmonary artery diameter and pressure measurements were evaluated for all patients. In cases where pulmonary artery branches are also aneurysmal, computed tomography was taken for the patients (Figure 1 and Figure 2). Coronary angiography was made for all patients before the operation. After completing pre-operative preparations, the patients were taken in the operation. Right or left jugular vein was used for central catheterization in all patients. After anesthesia application, esophageal probe was installed for heat control before heparinization. All patients were operated by applying standard median sternotomy incision under general anesthesia. Patients were full dose heparinized if there was no

pericardial adhesion after opening the pericardium. Medication to provide an activated clotting time (ACT) of 460 and above was applied for cardiopulmonary bypass (CPB). First aortic and then bicaval venous cannulation was made for CPB after reaching the aorta. Aortic roof cannula was used for cardioplegia and vent. Blood cardioplegia was used in every 20 minutes for cardioplegia. Patients included in the study were separated into two groups as those who had plication in PAA (Group I) and those who had tube graft change in PAA (Group II). There were six patients in Group I (2 F, 4 M) and five patients (2 F, 3 M) in Group II. Variables such as post-operative aortic cross clamp duration, total CPB duration, inotropic agent use, extubation duration, intensive care unit hospitalization duration and hospitalization in the service were registered and examined.

Statistics

Mean \pm standard deviation (mean \pm SD), percentages were used for descriptive statistics. For the comparison of both groups, t test and Wilcoxon tests were used. Statistical studies were made on acquired data with IBM Statistical Package for the Social Sciences 24.0 (SPSS 24.0, SPSS Inc, Chicago, IL) software. $p < 0.05$ was regarded as statistically significant in the comparisons.

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