Pavia Experience in Reoperative Pulmonary Endarterectomy

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In our experience, we reperformed pulmonary endarterectomy (PEA) in 10 patients who previously underwent a first PEA. We analyzed this cohort of patients to investigate the main causes of recurrence of symptomatic pathology and the clinical and hemodynamic results of redo surgery. Between 1994 and April 2016, 10 of 716 patients were reoperated at our institution. Available postoperative data were analyzed, and a comparison between first and second PEA hemodynamic and clinical results was carried out. In-hospital mortality rate was also evaluated. After reoperation, mean pulmonary arterial pressure decreased from 45 ± 9 to 34 ± 10 mm Hg, and pulmonary vascular resistance reduced from 932 ± 346 dyne*s*cm^{-5} to 428 ± 207 dyne*s*cm^{-5}. Hemodynamic data revealed worthy results of redo PEA, although they are less important than after first PEA. The World Health Organization (WHO) functional class improvement demonstrated satisfactory clinical results. In-hospital mortality of repeat PEA is 40%. Reoperative PEA operative candidacy should be assessed in case of young patients, no other risk factor, and recent medical history of pulmonary hypertension. In the other cases, in-hospital mortality rate is very high and pulmonary hypertension-specific drug therapy or interventional approach should be previously considered.

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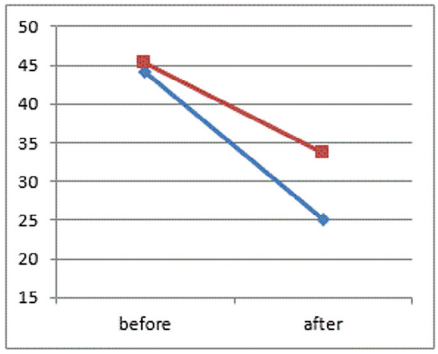

mPAP reduction after first (blue line) and redo (red line) PEA. (Color version of figure is available online.)

Central Message

Redo PEA should be considered in case of recurrence of symptomatic CTEPH, after discussion of perioperative risk.

Perspective Statement

The paper reports Pavia experience in reoperative pulmonary endarterectomy (PEA). Because in literature few mentions are present about this topic, this paper is a revision of surgical approach to CTEPH after PEA, in the era of pulmonary hypertension-specific drug therapy and balloon pulmonary angioplasty.

INTRODUCTION

Chronic thromboembolic pulmonary hypertension (CTEPH) is the only class of pulmonary hypertension curable with conservative surgery. This procedure is pulmonary endarterectomy (PEA).[1] In Italy, Pavia is the major referral center for PEA, and a total of 716 patients were operated between April 1994 and April 2016.

At our institution, only a minority of patients have experienced a recurrence of symptomatic CTEPH. Since April 1994, only 10 reoperations have been performed. The limited number of reoperations suggests that PEA remains an excellent treatment.[2] An optimally tailored anticoagulation therapy is necessary to avoid recurrences, because coagulation disorders are common in these patients.[3,4] The objective of our report is to analyze our cohort of redo patients to investigate the main causes of recurrence and the clinical and hemodynamic results of redo surgery. Moreover, because PEA remains the gold standard for CTEPH, against interventional and medical possibilities, there is the need to define whether surgical strategy is the optimal therapy even for recurrence of symptomatic pathology.

We report our experience in reoperative PEA. In our opinion, this is appealing because only 2 papers was published about this topic. In addition, the only 1 analysis of a reoperative PEA population[4] was performed when no other conservative therapy was available for inoperable or persistent or recurrent CTEPH. Nowadays, pulmonary hypertension-specific drug therapy and balloon

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pulmonary angioplasty can be offered to patients with CTEPH. For this reason, we believe that a revision on this topic in the light of new conservative therapies is necessary.

PATIENTS AND METHODS

To date, we have registered 10 cases of reoperative PEA. Of these cases, 1 patient has undergone 2 reoperations, so was considered twice in our analysis. Two patients had the first PEA surgery in another hospital. At our center, we operate a follow-up program to monitor the clinical state of patients after PEA. A re-evaluation of patients is performed 3-6 months after operation. Other follow-up visits are programmed yearly from the first to the fifth year and then 7, 10, 15, and 20 years after PEA. During each postoperative check-up, examinations such as transthoracic echocardiography, 6-minute walking test, pulmonary function study, diffusing capacity of the lungs for carbon monoxide, modified Bruce treadmill test, and right heart catheterization are repeated. In case of symptomatic patients with pulmonary hypertension at right heart catheterization, the follow-up evaluation is completed with a ventilation and perfusion scan and a chest computed tomography scan to determine the operative candidacy. After this set of examinations and an evaluation of risk factors, if chronic thromboembolic material is present in pulmonary arteries, operative candidacy is considered.

Concerning the surgical strategy, given that, in most cases, there is evidence of right heart dilatation and the presence of adhesions, cardiopulmonary bypass is started before sternotomy through a femoro-femoral cannulation.[5] The identification of the dissection plane for the PEA is tougher, considering that the vessels have been previously treated. Surgical parameters such as cardiopulmonary bypass time and circulatory arrests are reported in Table 1. No associated procedure was performed during either operations. After reoperation, anticoagulant therapy is recommended for all patients with an International Normalized Ratio target set between 2.5 and 3.5, as it was after the first intervention.

For our study, reoperative PEA data were collected, and a descriptive analysis was performed. At our institution an ongoing longitudinally study regarding PEA results allows us to collect and analyze preoperative, postoperative, and follow-up data of patients. All the patients involved in this paper signed an informed consent.

RESULTS

The population in our cohort is heterogeneous (Table 2). Six patients are male and 4 female. At the time of the first PEA, the age of patients was 46 ± 28 years on average. When the second PEA was performed, the age of patients was 52 ± 24 years. In 6 out of 10 cases, primary PEA was bilateral. Nine out of 10 patients had caval filter. There were multiple coagulation disorders in each patient. In particular, in 7 cases, anti-phospholipid antibodies were present, and lupus anticoagulant was positive in 4 patients. Anticoagulation was suboptimal in 4 cases after the former endarterectomy. In 2 patients, some of the lesions removed during the second PEA were already present at the time of the first operation, when they were judged as inoperable. In fact, the increase in the operability rate allowed even more distal lesions to be treated.

The analysis of the hemodynamic results revealed a similar pattern of reduction after both PEAs. After reoperations, mean pulmonary arterial pressure (mPAP) and pulmonary vascular resistance (PVR) decreased, by 26% and 54%, respectively (Fig. 1). Before first PEA, mPAP and PVR were, respectively, 44 ± 6 mm Hg and 1005 ± 263 on average, whereas after PEA, they fell to 25 ± 12 mm Hg and 342 ± 137 dyne*s*cm^{-5}. After reoperation, mPAP decreased from 45 ± 9 to 34 ± 10 mm Hg and PVR reduced from 932 ± 346 dyne*s*cm^{-5} to 428 ± 207 dyne*s*cm^{-5}. Postoperative hemodynamic data refer to the right heart catheterization performed before discharge. Figure 1 also shows the hemodynamic modification at 1- and 2-year follow-up. Postoperative values are available only for 8 patients, because the others died immediately after reoperation. Hemodynamic reduction was important, although mPAP and PVR remained higher than after first PEA. This could be due to the longer CTEPH medical history of the patients at the time of redo surgery. Considering the small vessel remodeling and its irreversibility, a longer period of pulmonary hypertension leads to a major vessels remodeling and consequent-

Table 1. First and Second PEA Surgical Data

Case	Sex	Jamieson First PEA	CPB First PEA	Arrests First PEA	Jamieson Second PEA	CPB Second PEA	Arrests Second PEA	Complications
1	M	1	250	2	1	510	6	Intestinal infarction
2	F	1	105	0	3	230	2	
3	F	3	230	2	4	435	6	Pneumonia
4	M	1	210	2	1	300	3	Persistence of PH
5	M	1	275	3	3	460	17	
6	M	n/a	n/a	n/a	4	280	4	
7	M	1	295	2	1	640	26	Massive hemoptysis
8	F	2	270	7	2	282	4	
9	M	3	395	8	3	460	11	
10	F	n/a	n/a	n/a	1	298	9	Right heart failure

Arrests, number of circulatory arrests; Complications, events that led to death; CPB, cardiopulmonary bypass time (expressed in minutes); Jamieson, Jamieson classification of lesions; n/a: not available data.
Data are not available for patients who underwent first PEA in other hospital.