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An Improved Technique for Pulmonary Endarterectomy

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We report a modified technique for pulmonary endarterectomy (PEA) on a 67-year-old man with chronic thromboembolic pulmonary hypertension (CTEPH) who presented with dyspnea. He was referred to our medical center for coronary artery bypass grafting. CTEPH had not been detected in his first visit to another medical center, but upon re-evaluation, the diagnosis was confirmed. PEA was performed with a modified method, which seems to be safe and suitable for the removal of clot and fibrotic materials. Iatrogenic dissection was performed with normal saline injection in the pulmonary artery, and then, the clot was removed completely. Although the technique may not be applicable for all cases, it can be used as an alternative to using an aspirating dissector and a pair of forceps.

Key words: 1. Endarterectomy
2. Pulmonary hypertension
3. Thromboembolism

CASE REPORT

Chronic thromboembolic pulmonary hypertension (CTEPH) is an important cause of severe pulmonary hypertension resulting in significant morbidity and mortality. As it is a potentially curable cause of pulmonary hypertension, its accurate diagnosis is vital. The gold standard and effective treatment for CTEPH is pulmonary endarterectomy (PEA) [1]. PEA is an uncommon procedure with less than fifty years of experience worldwide. Research on the development of new surgical approaches is essential. In the present case, a new successful surgical technique for PEA was introduced.

1) Case report

A 67-year-old man presented with a chief complaint of dyspnea and fatigue. He had a history of dyspnea and exertional chest pain for several years, which had worsened in the last few months (New York Heart Association functional class III). He was referred to our center for coronary artery bypass grafting (CABG). He was a farmer with a cardiac risk factor of occasional smoking. He had no history of orthopedic surgery, deep vein thrombosis, being bed ridden, or long air travel. He had transitional cell carcinoma of the bladder 3 years previously and was completely treated with bacillus Calmette–Guerin (BCG). Physical examination revealed an elevated neck vein, loud P2, tachypnea, and light edema of

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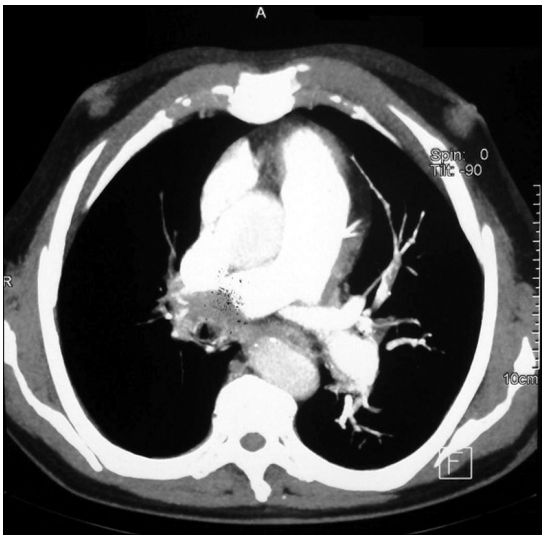

Fig. 1. Lung computed tomography scan with contrast angiography showing a filling defect in the right pulmonary artery leading to complete obstruction.

the feet.

In evaluations performed previously in another medical center, an electrocardiogram showed sinus tachycardia (heart rate, 110 beats/min), normal axis, normal P wave, right ventricular hypertrophy, and 1-mm ST depression in V1 to V3. An echocardiographic study revealed normal left ventricular systolic function and size, right ventricle (RV) enlargement and dysfunction, moderate tricuspid regurgitation, and dilated inferior vena cava with minimal collapsibility. Based on echocardiographic data, the estimated systolic pulmonary pressure was 55 mmHg. Cardiac catheterization showed three-vessel disease, and therefore, CABG was recommended.

As the chest X-ray and the pulmonary function test were normal, it seemed that the patient's pulmonary hypertension was not related to chronic obstructive pulmonary disease (COPD) or interstitial lung disease (ILD), although he engaged in farming and smoked occasionally. The patient's symptoms could not be explained by coronary artery disease; therefore, further evaluation was needed. A lung computed tomography (CT) scan with contrast angiography was performed. It revealed a filling defect compatible with chronic pulmonary thromboembolism in the right pulmonary artery (RPA) leading to its complete obstruction (Fig. 1). We also decided to perform right heart catheterization to measure the patient's hemodynamic parameters in order to confirm CTEPH.

All findings were suggestive of CTEPH; therefore, surgical embolectomy was recommended. Evaluation of the patient prior to surgery excluded predisposing factors of CTEPH including antiphospholipid antibodies, anticardiolipin antibodies, lupus anticoagulant, and inflammatory bowel disease. The only suspicious risk factor was a history of superficial transitional cell carcinoma of the bladder, treated previously with BCG.

2) Surgical technique

The patient was intubated, and after inserting monitoring devices, we performed median sternotomy. Cannulae were inserted into both the vena cava and the ascending aorta encircled with tapes. Cardiopulmonary bypass was established under moderate (range, 26°C to 31°C) hypothermia. The aorta was clamped, and a cold cardioplegic solution was infused into the aortic root with subsequent infusions of the same solution every 15 to 20 minutes. During cooling, the superior vena cava (SVC) was immobilized to the level of the innominate vein, but the azygos vein was not divided. The RPA was mobilized by retracting the vena cava laterally and the aorta medially by using encircling tapes. After establishing cardiac arrest, the purse-string suture technique was performed with noncutting needles on the RPA, and a 4-mm stab wound was created within the purse-string sutures. An endarterectomy plane was established using a sharp dissector, and the intima and a portion of the media were dissected. Establishing the correct plane is important as a very deep plane will result in perforation of the vessel and a plane that is too superficial will result in inadequate endarterectomy. A gray angiocatheter (no.16) was then inserted into the dissected area, and about 700 mL of normal saline was injected gently into the space. Performing external massage with the fingers on the RPA helped spread the liquid, which facilitated the dissection within the RPA. After completing the dissection in the distal part of the RPA, the incision on the proximal part was extended, and then, the endarterectomy material was removed (Fig. 2). Finally, the RPA incision was repaired with Prolene 5-0.

After PEA, coronary artery bypass grafting was performed,

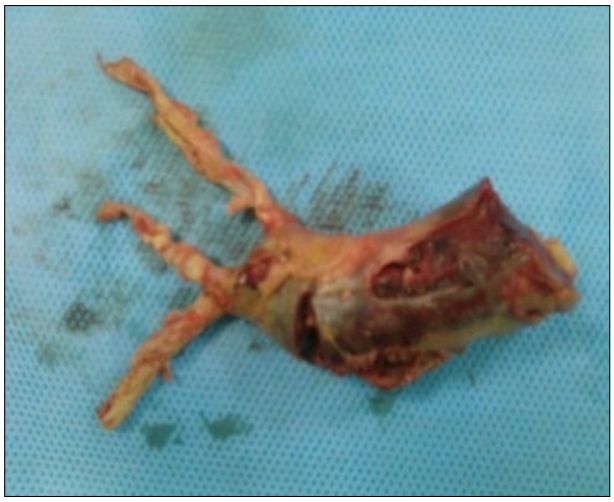

Fig. 2. Macroscopic view of the endarterectomy specimen.

and four veins and one internal mammary artery were anastomosed to the coronary arteries. The cardiopulmonary bypass duration was 2 hours and 20 minutes, and the aortic clamp duration was 1 hour and 50 minutes. After re-warming and heart beat restoration, cardiopulmonary bypass was discontinued, the cannulae were removed, and the rest of the surgery was completed under standard conditions.

The patient was transferred to the intensive care unit. He was hospitalized for 4 days and discharged in good general condition. The postoperative day 2 echocardiogram showed a significant decrease in the size of the right heart chambers, decreased systolic pulmonary pressure (from 55 to 30 mmHg), improved RV function, and reduced tricuspid valve regurgitation. The lung CT scan with contrast angiography showed complete reopening of the right pulmonary artery and its lobar branches.

DISCUSSION

CTEPH is a disabling disease referred to a late onset complication of pulmonary thromboembolism that decreases the patient's functional status and reduces the patient's chance of survival. The main cause of death in such patients is usually right ventricular failure [2]. CTEPH is misdiagnosed in many cases as occurred for our patient at his first visit. The patient's dyspnea had been previously attributed to COPD or ILD. As no positive findings were obtained by chest X-ray and PFT, performing the lung CT scan with contrast angiography indicated a filling defect compatible with chronic pulmonary thromboembolism in the RPA leading to its complete obstruction.

The available treatments for CTEPH include medical therapy, PEA, and pulmonary transplantation [3]. Lung transplantation is not recommended as the first step due to its unsatisfactory results: a postoperative mortality rate of 20% and a 5-year survival rate of 50% [4]. Medical therapy is appropriate only in patients with inoperable or residual postoperative CTEPH. The treatment of choice for CTEPH is surgical PEA leading to normal pulmonary hemodynamics in 80% of the patients [5].

Most probably, the first PEA was performed in May 1962 by Dr. Charles Hufnagel [6]. In 1970, Nina Braunwald performed the first operation using a right lateral thoracotomy and cardiopulmonary bypass at the University of California San Diego (UCSD) [7]. Since then, the technique has been modified progressively, including the use of median sternotomy and hypothermic circulatory arrest, more proximal incisions, an approach to the right side beneath the SVC rather than above it, and the avoidance of more than one arteriotomy on each side. The technique for endarterectomy was mainly developed by Dr. W. Jamieson at UCSD. In the routine procedure, after circulatory arrest is established, an incision is made in the pulmonary artery (PA) between the aorta and the SVC. Any loose thrombotic material debris, if present, is removed. The correct plane is established with a sharp dissector, and intima and a part of media are removed. Then, the fibrotic material is grasped gently with a pair of forceps while sweeping away the outer vessel wall layer with an aspirating dissector resulting in the progressive withdrawal of the endarterectomy specimen [8].

Although PEA is the gold standard of treatment, its perioperative mortality is about 10% (range, 4% to 24%) [5,9,10]. Yet, PEA remains an unusual procedure. The method does not support complete clot removal, and the outcome is highly dependent on the degree of thrombotic specimen extraction and damage to the pulmonary artery bed. The aspirating dissector can be harmful for the pulmonary artery and may cause perforation in the PA. In our center, PEA was done as mentioned above with the exception that saline in-

jection was used instead of an aspirating dissector and a pair of forceps. The modification seems to be safe and convenient.

In conclusion, the surgical procedure used on the present patient was a unique technique and performed for the first time in the world. We do not claim that our technique is better than the original San Diego technique, but it is suggested as a modification that may improve patient survival. However, this procedure has its own limitations and cannot be used for clots that are located distally. Therefore, further experience should be obtained in order to overcome the limitations and improve the applicability of the technique.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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