Operability Assessment and Postoperative Outcome in Chronic Thromboembolic Pulmonary Hypertension

Norikazu Yamada, MD, PhD

Since the first reported case of successful pulmonary thromboendarterectomy (PTE) for chronic thromboembolic pulmonary hypertension (CTEPH) in 1961, PTE has become an established and potentially curative treatment for affected patients. Hemodynamics and functional capacity, such as the 6-min walk distance and New York Heart Association (NYHA) class, markedly improve after successful PTE. The 30-day mortality ranges from less than 5% in the most experienced centers to 10% elsewhere. Current indications for the application of PTE include: (1) NYHA functional class III or IV symptoms; (2) preoperative pulmonary vascular resistance (PVR) >300 dyne·s⁻¹·cm⁻⁵; (3) surgically accessible thrombus in the main, lobar or proximal segmental pulmonary arteries; and (4) no severe comorbidities. All patients with suspected CTEPH should be referred to an experienced center for confirmation of diagnosis and specific assessment of operability. Although advancement in surgical techniques have allowed successful resection of segmental-level thromboemboli, PTE may not be offered to up to 40% of patients because of distal or inaccessible lesion or comorbidities. The outcome of PTE is largely dependent on the preoperative hemodynamics and accessibility for the thromboemboli. It is well known that a high preoperative PVR is associated with increased mortality and poor hemodynamic outcome. Jamieson et al reported that patients with a preoperative PVR >1,000 dyne·s⁻¹·cm⁻⁵ had a significantly higher mortality rate than those with a preoperative PVR <1,000 dyne·s⁻¹·cm⁻⁵ (10.1% vs. 1.4%; P<0.0001). Because residual pulmonary hypertension (PH) is the most important determinant of postoperative outcome, the preoperative identification of patients with CTEPH with concomitant small pulmonary arterial disease and/or microvascular disease is crucial. The preoperative assessment of the degree and contribution of small-vessel disease is an important factor in determining operability.

Article p476

Thistlethwaite et al proposed a useful intraoperative classification of CTEPH in providing information to guide patient management: type I = fresh thrombus in the main or lobar pulmonary artery; type II = organized thrombus and intimal thickening proximal to segmental arteries; type III = intimal thickening-fibrosis in distal segmental arteries, with surgical plane raised at each segmental level; and type IV = microscopic distal arteriolar vasculopathy with removal of normal intimal layer and no thrombus. It has been shown that patients with type III or IV disease have higher postoperative pulmonary artery systolic pressures, and higher postoperative pulmonary vascular resistance than those with type I or II disease. A small subset of patients classified into type IV has a diffuse, small-vessel vasculopathic process of medial hypertrophy. This group has the highest perioperative mortality, greatest average length of hospitalization, and highest overall incidence of postoperative complications. Although current available diagnostic tools are adequate in identifying the presence of proximal lesions in CTEPH, they provide only limited information on the status of the microvasculature.

In this issue of the Journal, Yamaki et al report that an index of occlusion in CTEPH (IOCTEPH), which indicated the degree of occlusion in small pulmonary arteries of specimens obtained by lung biopsy during PTE correlated well with postoperative hemodynamic data and clinical conditions. In addition, the removal of the thrombus in the proximal pulmonary artery lead to pulmonary hemorrhage from destruction of collateral vessels or vessels with atrophic thin wall when collateral circulation has formed or when there is severe atrophy of the small peripheral pulmonary arteries. In fact, a patient with high IOCTEPH and a large number of collateral vessels surrounding obstructed small pulmonary arteries in the specimens from lung biopsy died intraoperatively. And the death of another patient with severe medial atrophy in the precinar and intraacinar small pulmonary arteries recruited after development of the criteria for lung biopsy was associated with surgery. Based on these results, the authors conclude that intraoperative lung biopsy is useful to predict prognosis after PTE for CTEPH in patients with mean pulmonary artery pressure of ≥40 mmHg or PVR of ≥800 dyne·s⁻¹·cm⁻⁵.

Because data for evaluation of the correlation between the histopathologic findings of pulmonary arteries from specimens obtained by lung biopsy during PTE and surgical outcomes are very limited to date, the current authors provide valuable information. However, surgical lung biopsy is associated with unacceptable high risk in patients with marked PH and is generally avoided preoperatively. Another issue is the heterogeneity of the pulmonary vascular changes in CTEPH. Unlike pulmonary arterial hypertension of which peripheral pulmonary vessels are involved homogeneously, it is thought that the histopathologic findings of peripheral pulmonary arteries differ greatly between biopsy sites from CTEPH patients and it is difficult to estimate the vessel changes in the whole lung from the limited amount of specimens that can be obtained by biopsy. Although
the degree of occlusion of each individual small pulmonary artery is considered to affect the prognosis, a noninvasive preoperative assessment method of small pulmonary arteries has not been established. Recently, the pulmonary artery occlusion technique for assessing the relative contribution of small vessels to the PVR was suggested as a promising tool for determining the preoperative risk in CTEPH patients with high PVR. It is necessary to establish the preoperative assessment tools to accurately assess surgical risk and expected outcome after PTE.

Besides PTE, potential alternative treatments have been developed. Percutaneous transluminal pulmonary angioplasty (PTPA) is an intervention expected to improve not only the patient’s hemodynamic data but also exercise capacity and prognosis, and can be applied to those patients for whom PTE is not an option because of distal surgically inaccessible lesions or resection, and can be applied to those patients for whom PTE is not possible (Figure). Furthermore, a recent randomized, double-blind, placebo-controlled study demonstrated that a soluble guanylate cyclase stimulator, riociguat, significantly improved exercise capacity and PVR in patients with inoperable CTEPH or persistent or recurrent PH after PTE. In the near future, these new options might advance the treatment strategy for inoperable CTEPH patients or CTEPH patients with residual PH after PTE (Figure).

**References**


