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*Editorial*

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# Balloon Pulmonary Angioplasty (BPA) and Rehabilitation for Chronic Thromboembolic Pulmonary Hypertension (CTEPH)

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Chronic thromboembolic pulmonary hypertension (CTEPH) has a poor prognosis because of increased pulmonary arterial pressure (PAP) causing pulmonary hypertension and progressive right-sided heart failure.[1,2] Typical symptoms are dyspnea on exertion, fatigability, and reduced quality of life.[3] Balloon pulmonary angioplasty (BPA) has been reported to improve hemodynamics and functional capacity in patients with CTEPH who are not candidates for pulmonary endarterectomy.[4,5] However, the effect of BPA on respiratory function in patients with CTEPH is unclear.

Recently, Akizuki et al[3] investigated how BPA affects hemodynamics, ventilatory efficiency, and gas exchange in patients with CTEPH using right heart catheterization, respiratory function testing, and cardiopulmonary exercise testing (CPX).[3] They enrolled patients with inoperable CTEPH who underwent BPA primarily in lower lobe arteries and upper and middle lobe arteries. They compared changes in hemodynamics and respiratory function between different BPA fields.

They showed differences in the effect of BPA on respiratory function in different BPA fields in patients with CTEPH. Mean PAP and pulmonary vascular resistance significantly improved. Oxygenation at rest and during exercise improved regardless of the BPA field.

However, the time course of changes in the percent predicted diffusion capacity of lung for carbon monoxide (% $D_{LCO}$), The ventilation/$CO_2$ production ($V_E/V_{CO2}$) slope, and $FET_{CO2}$ was significantly different between lower and upper/middle lung BPA fields. $\%DL_{CO}$ decreased after BPA in the lower lung field with no recovery. However, $\%DL_{CO}$ increased after BPA in the upper middle lung field and continued to improve during the follow-up. $V_E/V_{CO2}$ slope significantly improved after BPA in the lower lung field and continued to improve during the follow-up. However, the $V_E/V_{CO2}$ slope remained unchanged after BPA in the upper/middle lung field. Therefore, the effect of BPA on respiratory function in patients with CTEPH differed depending on the lung field.[3]

Based on their results, they suggested that BPA in the lower lung field improves oxygenation and respiratory function parameters during exercise, such as $V_{E/}V_{CO2}$ slope and $FET_{CO2,}$ because of remarkable improvement in hemodynamics. They also suggested that BPA in the upper/middle lung field may improve oxygenation and respiratory function parameters at rest, such as $\%DL_{CO}$, caused by improvement in V/Q mismatch.[3]

However, reduced $D_{LCO}$ in CTEPH reflects not only the effect of low V/Q but also dead space ventilation (deadspace/tidal volume [$V_D/V_T$]) in regions with high V/Q.[6] Further, one hypothesis suggests that in patients with CTEPH, a decrease in $D_{LCO}$ also indicates microvascular remodeling.[6] Results of previous reports that $D_{LCO}$ remained unchanged even after successful pulmonary endarterectomy and BPA supported the hypothesis.[7,8]

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These points of view suggest that reduced $D_{LCO}$ in patients with CTEPH may be caused by low V/Q, high V/Q and microvascular remodeling.[6] Therefore, it is important to distinguish the effects of these three components when discussing $D_{LCO}$ in CTEPH. To obtain further evidence to support their hypothesis, Takei et al[6] suggest analyzing the $V_D/V_T$ and shunt fraction (Qs/Qt) to distinguish the amelioration of high V/Q and deterioration of low V/Q in different lung lobes.[6]

The goal of effective CTEPH management is to relieve symptoms, slow disease progression, improve exercise tolerance, prevent and treat complications, and improve prognosis and overall quality of life. The clinical presentation of CTEPH is similar to pulmonary arterial hypertension (PAH) with nonspecific symptoms. Further studies are required to elucidate to noninvasively examine the severity of CTEPH and to noninvasively distinguish CTEPH from PAH, for example, by respiratory function or ventilator gas analysis in different postures.

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