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Optical Coherence Tomography as a Novel Diagnostic Tool for Distal Type Chronic Thromboembolic Pulmonary Hypertension

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The new classification of pulmonary hypertension (PH) has been recently updated,[1] in which 5 major categories of the disorder have been classified. Among them, pulmonary arterial hypertension (PAH, class 1) and chronic thromboembolic PH (CTEPH, class 4) are characterized as having similar hemodynamic pulmonary circulation despite their different pathological vascular structures.

Optical coherence tomography (OCT) is an interferometer-based optical imaging modality that produces a 2-dimensional image of optical scattering from internal tissue microstructures with a high resolution of approximately 10–20 μm, 10-fold higher than that of intravascular ultrasound.[2–4] Here, we report the potential usefulness of OCT as a novel diagnostic tool for the differential diagnosis of distal type CTEPH from PAH.

The Ethics Committees of Tohoku University Hospital approved the study protocol and all patients provided written informed consent. We prospectively enrolled 31 consecutive patients with PH, including PAH (n=17), CTEPH (n=9), and normal hemodynamic subjects (control, n=5), who were

Table. Subject Characteristics

	Control	PAH	CTEPH	P value
n	6	18	9	
Age (years)	64.2±4.7	45.6±3.7	60.2±4.4	<0.05
Gender, n (%)				
Male	1 (17)	6 (33)	0 (0)	NS
Female	5 (83)	12 (67)	9 (100)	NS
Type of PH, n (%)				
IPAH	–	6 (33)	–	
CTD-PAH	–	9 (50)	–	
CHD-PAH	–	2 (11)	–	
Portal hypertension-PAH	–	1 (6)		
Hemodynamic variables				
PCWP (mmHg)	9±1	8±1	9±1	NS
Mean PAP (mmHg)	15±1	42±4	42±4	NS
CI ($L \cdot ml^{-1} \cdot m^{-2}$)	2.8±0.3	2.9±0.2	3.0±0.2	NS
Mean PVR ($dyne \cdot s^{-1} \cdot cm^{-5}$)	130±28	718±149	585±80	NS
OCT findings, n (%)				
Thrombus formation	0 (0)	0 (0)	4 (44)	<0.05
Luminal flaps	0 (0)	0 (0)	6 (67)	<0.01

Data are expressed as mean±SEM. Statistical analysis was performed between PAH and CTEPH, using unpaired t-test for continuous variables and chi-square test for categorical variables, using Stat View (SAS Institute, Cary, NC, USA).
PAH, pulmonary arterial hypertension; CTEPH, chronic thromboembolic pulmonary hypertension; PH, pulmonary hypertension; IPAH, idiopathic PAH; CTD, connective tissue disease; CHD, congenital heart disease; PCWP, pulmonary capillary wedge pressure; PAP, pulmonary arterial pressure; CI, cardiac index; PVR, pulmonary vascular resistance; OCT, optical coherence tomography.

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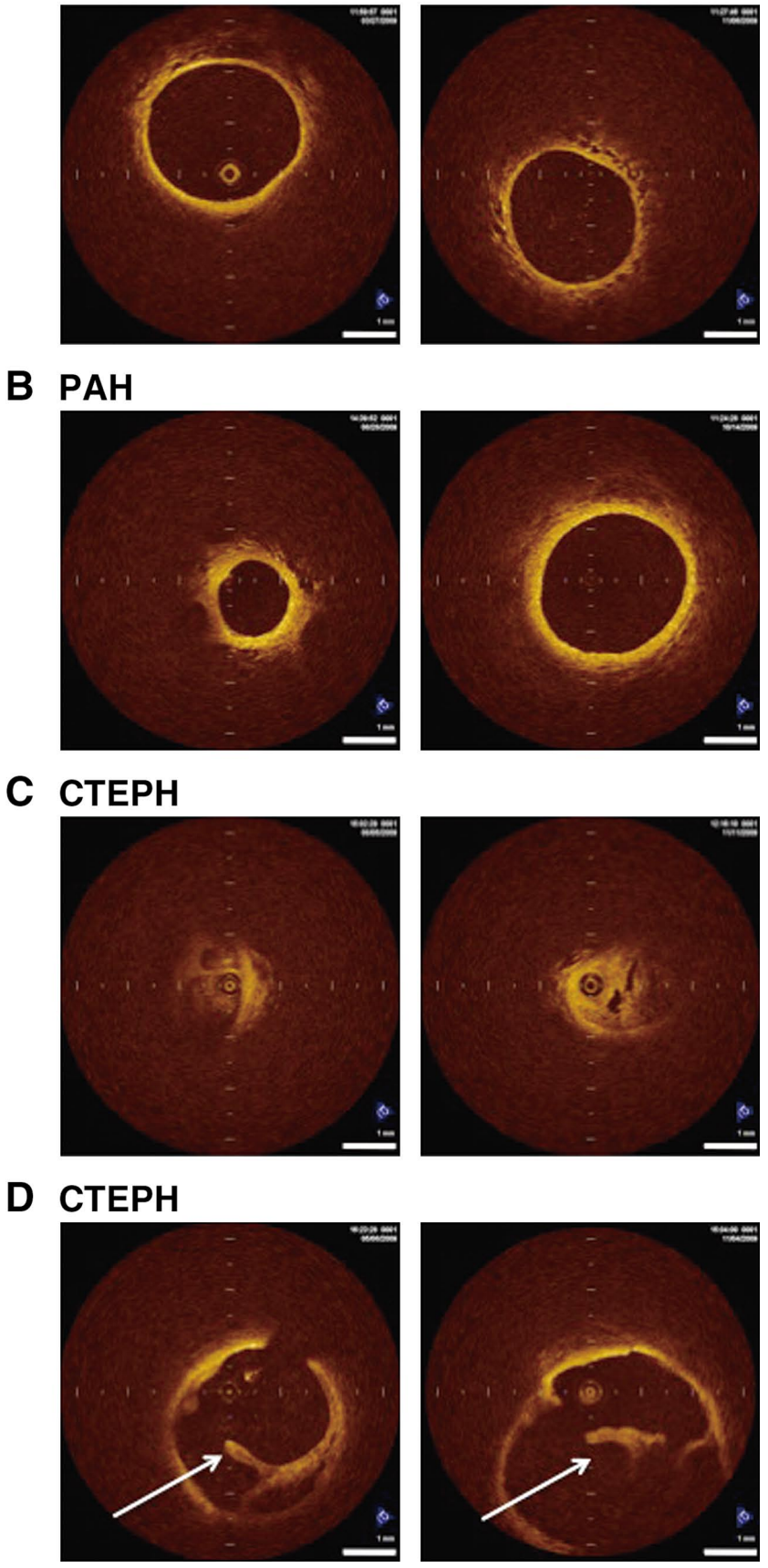

Figure. Optical coherence tomography (OCT) of the pulmonary arteries from (**A**) control subjects, (**B**) pulmonary artery hypertension (PAH) patients, and (**C**,**D**) chronic thromboembolic pulmonary hypertension (CTEPH) patients. The media of the pulmonary artery is thickened in (**B**) PAH, as compared with (**A**) controls. In contrast, in CTEPH, the pulmonary arteries have a very different OCT appearance with either (**C**) thrombotic occlusion and/or (**D**) luminal flaps (arrows). Bar, 1.0 mm.

admitted to Tohoku University Hospital from February 2009 to December 2009 and underwent right heart catheterization including OCT (Table). Pulmonary arteries >1 mm in diameter had no obstruction in the control or PAH subjects, although the media of the arteries appeared to be thickened in PAH subjects compared with controls (Figures A,B). In contrast, in all cases of CTEPH, we obtained completely different findings as compared with the control or PAH subjects; half of the CTEPH patients had occlusion of the pulmonary arteries, probably by thrombus (Figure C), and more than half of them had flaps in the lumen of the pulmonary arteries (Figure D; Table).

Pathohistological studies have demonstrated that idiopathic PAH is associated with abnormal vascular structures, including medial and/or intimal hypertrophy, concentric and/or eccentric intimal fibrosis, obstruction in the arterial lumen, and aneurysmal dilatation in vessels <300 mm in diameter.[5–7] In contrast, CTEPH is caused by the obstruction of pulmonary arteries by thrombus and is mainly observed in large vessels.[8,9] The present results indicate that OCT is a potentially useful tool for the differential diagnosis of distal type CTEPH from PAH.

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