

First remote-controlled robotic-enhanced balloon pulmonary angioplasty to chronic thromboembolic pulmonary hypertension

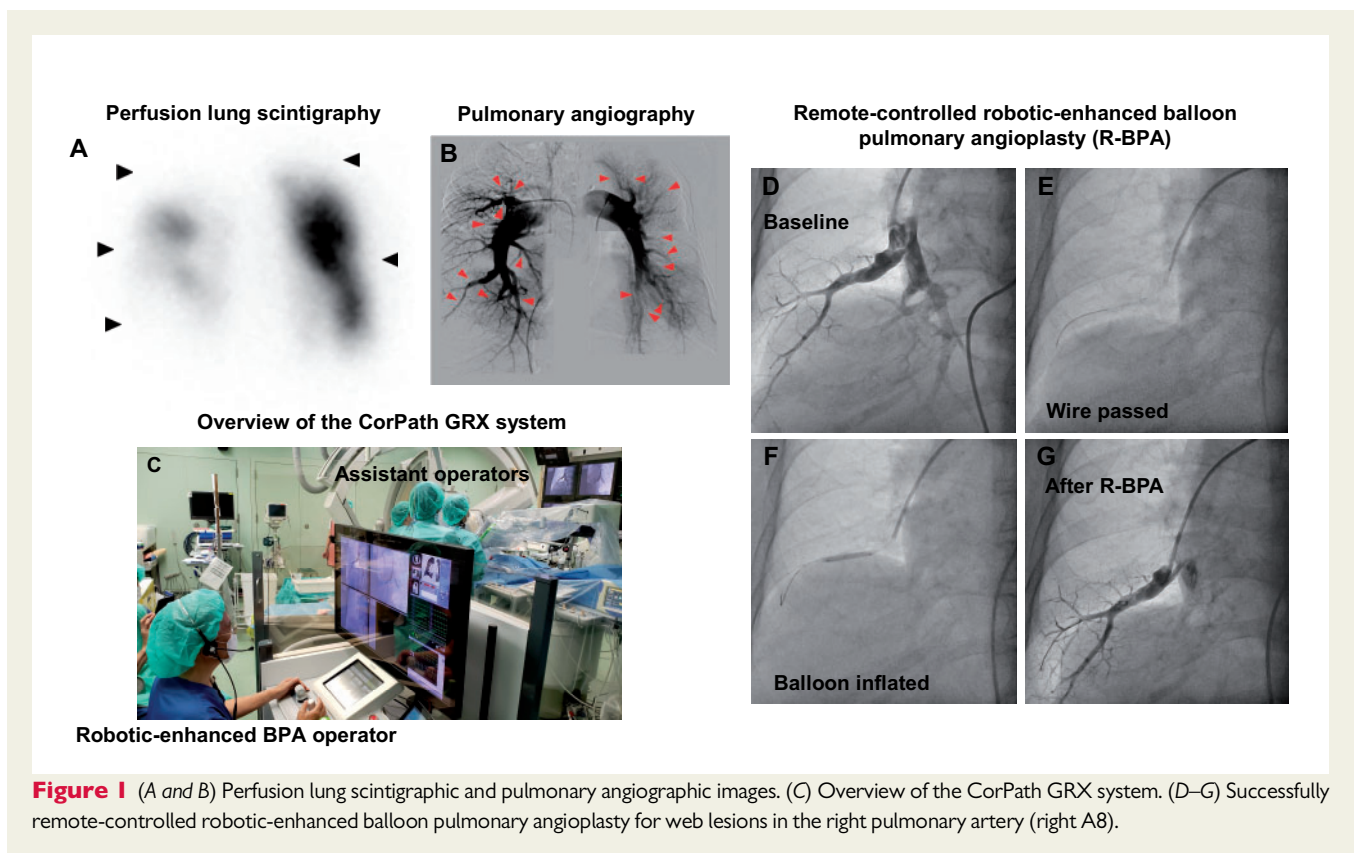
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In recent years, balloon pulmonary angioplasty (BPA) has emerged as a therapeutic option for surgically ineligible patients with chronic thromboembolic pulmonary hypertension

(CTEPH).^{1–3} It provides haemodynamic, functional, and prognostic benefits to inoperable CTEPH patients.² However, it is not easy to select the target vessels during BPA due to a number of



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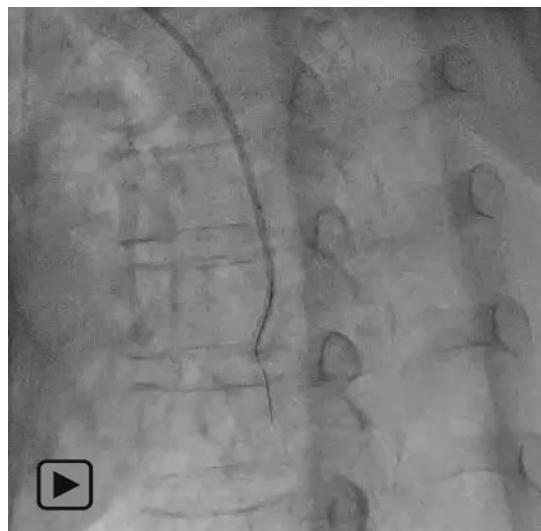
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Video 1 A 0.014-inch guidewire (B-pahmTM, Japan Lifeline, Tokyo, Japan) was passed across the web lesion in the right A8 supported by a 3.0×20 mm semi-compliant balloon (IKAZUCHITM PAD, Kaneka, Osaka, Japan).



Video 2 A 0.014-inch plastic coating guidewire (ChevalierTM 14 floppy BPA, NIPRO, Osaka, Japan) was selected the web lesion in the left A8 since it was difficult to pass using a 0.014-inch guidewire (B-pahmTM, Japan Lifeline, Tokyo, Japan) in this lesion.

branches of the pulmonary artery. It may require a high radiation dose for a long-time procedure. Therefore, technology to assist BPA is desired for the reduction of radiation exposure to the operators. Here, we report the first experience of remote-controlled robotic-enhanced BPA (R-BPA) for the treatment of CTEPH.

An 83-year-old female receiving anticoagulant therapy (Edoxaban 15 mg/day) for pulmonary thromboembolism during 4 years was referred to our hospital due to exertional shortness of breath. Six-minute walk distance (6MWD) was 159.0 m with desaturation to 75%. Perfusion lung scintigraphy demonstrated segmental perfusion defects in the bilateral lungs (Figure 1A; arrowheads). Right heart catheterization confirmed the diagnosis of pulmonary arterial hypertension with a pulmonary arterial pressure (PAP) of 70/12 (mean PAP 36 mmHg) mmHg, a mean pulmonary arterial wedge pressure (PAWP) of 4 mmHg, a cardiac index of 3.53 L/min/m², and a pulmonary vascular resistance (PVR) of 9.07 Wood Units. Pulmonary angiography indicated multiple webs, bands, abrupt vascular narrowing, and vascular obstruction suggesting the presence of multiple organized thromboemboli in the pulmonary arteries, which support diagnosis of distal-type CTEPH (Figure 1B, red arrowheads). We initiated a soluble guanylate cyclase stimulator (Riociguat 3 mg/day) and increased to 6 mg/day. Furthermore, we decided to perform an R-BPA procedure for the multiple lesions in order to prevent excessive radiation exposure to the operator. The CorPath GRX system consists of an interventional cockpit and a bedside unit (Figure 1C). First assistant operator set femoral access with an 8-Fr sheath and manually engaged a guiding catheter JR 4.0 to the right pulmonary artery. Second and third assistant operators connected a guiding catheter and a wire to a robotic system. The R-BPA operator crossed a wire and delivered a balloon to target lesions by using a robotic system in the interventional cockpit. The second assistant operator manually

inflated a balloon to dilate the lesions. The R-BPA was undergone for four web lesions in the four branches of the pulmonary arteries (right A8; Figure 1D–G, Video 1 and left A10; Video 2). However, the wire did not pass robotically to subtotal and web lesions of other segmental branches. A manual BPA (M-BPA) allowed to penetrate for these lesions instead. No periprocedural complication was observed during the R-BPA procedure. In this procedure, the radiation exposure to the R-BPA operator was 1.0 μGy, although those to first and second assistants were 58.0 μGy and 28.0 μGy, respectively. Procedure length and radiation exposure to the first assistant operator without robotic assistance from April 2019 to February 2020 in our centre were 157.9 ± 24.3 (mean ± standard deviation) minutes and 53.0 (18.5–94.3) [median (interquartile range)] μGy, respectively. Riociguat was decreased from 6 mg/day to 4.5 mg/day. One month after the BPA procedures, pulmonary haemodynamics were ameliorated with a PAP 51/16 (mean PAP 28 mmHg) mmHg, a mean PAWP of 7 mmHg, a cardiac index of 3.53 L/min/m², and a PVR of 5.95 Wood Units. The 6MWD was extended to 224.9 m with desaturation to 83%. Serial imaging of perfusion lung scintigraphy and pulmonary angiography demonstrated that the distribution of pulmonary blood flow was improved by R-BPA, R+M-BPA, and M-BPA (Supplementary material online, Figure S1).

Very recently, the remote-controlled robotic-enhanced percutaneous coronary intervention has been performed as a new strategy for low radiation exposure to the operator in patients with coronary artery disease.³ The R-BPA may also contribute to decrease the radiation exposure for the operator.

Supplementary material

Supplementary material is available at *European Heart Journal - Case Reports* online.

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Consent: The authors confirm that written consent for submission and publication of this case report including images and associated text has been obtained from the patient in line with COPE guidance.

Conflict of interest: None declared.

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