

Zero Contrast BAP Treatment Guided by Real-Time Fusion of CT Angiography with X-Ray Fluoroscopy: A Novel BPA Technique

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INTRODUCTION

Chronic Thromboembolic Pulmonary Hypertension (CTEPH) is a critical condition characterized by arterial thromboemboli, originating from the lower extremities veins and the right heart system to the pulmonary artery, leading to pulmonary artery embolism, increased right ventricular afterload, eventual decompensation, and the development of right heart failure. Pulmonary Endarterectomy (PEA) is the preferred treatment for CTEPH. For patients with subsegmental or distal pulmonary artery lesions unsuitable for PEA, Balloon Pulmonary Angioplasty (BPA) offers a viable therapeutic option. BPA has demonstrated its efficacy in alleviating pulmonary artery stenosis, reduce pulmonary vascular resistance, and consequently improvement in right heart function.

DESCRIPTION

BPA treatment without contrast media

In BPA procedures, iodinated contrast agents are used for super selective pulmonary artery angiography to display the site and lumen diameter of the pulmonary artery stenosis, thereby accurately selecting a balloon that matches the narrow part and lumen diameter for dilating the pulmonary artery. For patients with severe allergies to iodinated contrast medium, BPA treatment is contraindicated. The author reported a case of a CTEPH patient with a severe allergic reaction to iodine contrast agent and successfully underwent zero-contrast BPA surgery. This was achieved by leveraging 3D reconstruction of prior pulmonary artery CT images and real-time image fusion navigation. The specific method was as follows: using the GE IGS 530 system (GE Healthcare, Buc, France) and AW 4.7 post-processing workstation (GE Healthcare), the previous MDCT images were transmitted back to the AW workstation via Picture Archiving and Communication System (PACS) for navigation preparation. The AutoBone Xpress function facilitated the automatic bone removal interface, allowing for manual cutting

and extraction of the trachea and ribs, followed by the application of volume rendering techniques for visualization. Another window was used to reconstruct the pulmonary artery vascular structure with this method, marked with the value assist 2 image fusion software (GE Healthcare) and exported for the registration of the spine and organs. After the structures were matched, the system switched to vascular imaging for real-time navigation, efficiently guiding the guidewire through the pulmonary artery and displaying the position of the guidewire and balloon in real time. Intraoperative Intravascular Ultrasound (IVUS) was employed to pinpoint the narrow pulmonary artery vessel, accurately measuring the luminal diameter and lesion length. No contrast agent was used throughout the operation, with no adverse reactions during or after the procedure. Postoperatively, there was a significant reduction in average pulmonary arterial pressure and pulmonary vascular resistance; the patient showed good recovery at a six-month follow-up.

Future prospects and challenges

The author believes that zero-contrast BAP treatment for CTEPH patients with allergic reaction to iodinated contrast agents, guided by real-time fusion using X-ray fluoroscopy and CT angiography, is safe and effective. For patients with severe renal insufficiency who cannot use iodinated contrast agents, this technique also provides an effective treatment option. Intraoperative use of OCT or IVUS can accurately locate the lesion site, thereby providing precise guidance for BPA treatment. However, further observation and research are needed to assess the safety and effectiveness of this technique for complex lesions such as tortuous occlusion of the pulmonary artery lumen.

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