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**Role of anatomical regurgitant orifice area of the tricuspid valve measurements in patients with
beyond severe tricuspid regurgitation**

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Running head: Significance of AROA in beyond severe TR

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Author contributions

Conception/design of the study: Michito Murayama; management of the patient: Suguru Ishizaka; collection and interpretation of the data: Michito Murayama, Suguru Ishizaka, Keita Sakaguchi, Rion Ando, Sanae Kaga, and Hisao Nishino; analysis/interpretation of the data: Michito Murayama, Suguru Ishizaka, Keita Sakaguchi, and Rion Ando; drafting the article: Michito Murayama; counsel for the discussion section: Michito Murayama, Suguru Ishizaka, Keita Sakaguchi, Rion Ando, Sanae Kaga, Hisao Nishino, and Toshihisa Anzai; critical revision of the manuscript: Suguru Ishizaka, Sanae Kaga, Hisao Nishino, and Toshihisa Anzai; funding: Michito Murayama. All authors have read and approved the final manuscript.

A 37-year-old man with Epstein–Barr virus infection-induced cardiomyopathy showing severe mitral regurgitation was transferred to our hospital for transcatheter mitral valve repair. Electrocardiography showed atrial fibrillation. Transthoracic echocardiography was performed using Aplio i900 system. It revealed an enlarged left ventricle and a reduced ejection fraction. Color Doppler imaging revealed severe atrial functional mitral regurgitation. Additionally, severe functional tricuspid regurgitation (TR) was observed. Owing to concerns of right-to-left shunting across iatrogenic atrial septal defect associated with transseptal access, dehydration with loop diuretics was performed before mitral valve repair. Post-treatment, a weight loss of 7 kg was achieved, and TR was reassessed.

Post-treatment, color Doppler imaging showed that TR remained severe. The severity was confirmed using PISA. PISA radius with the same Nyquist limit pre- and post-treatment remained unchanged (**Fig. 1**). As it was difficult to objectively demonstrate the changes in TR severity, 3D analysis of the tricuspid valve was performed using customized software[1]. The closed tricuspid leaflet was traced in mid-systole on successive planes at angular intervals of 10°–15° radially from the center of the coaptation gap to generate coordinate information of the tricuspid annulus and leaflets. The software then determined the anatomical regurgitant orifice area (AROA). A significant reduction in the AROA was observed between pre- and post-treatment (320–40 mm²). Similar findings were observed using multiplanar reconstruction with the manufacturer's software of Aplio i900 system. Right heart catheterization revealed a low mean right atrial pressure of 2 mmHg. Based on these findings, we confirmed risk reduction of right-to-left shunting.

Transcatheter tricuspid valve interventions have emerged as safe and effective therapies[2], and a new TR grading scheme is being increasingly used[3]. In this scheme, a multiparametric approach using color Doppler parameters is proposed; however, color Doppler imaging is not recommended as the primary method for assessing TR severity[4] because of the lower pressure in the right side of the heart and the potential to underestimate severity, especially in torrential TR with a large coaptation gap showing laminar TR. Recently, the usefulness of the AROA, a flow-independent anatomical measure of TR severity, was reported[1, 5]. To the best of our knowledge, this is the first report on the usefulness of 3D transthoracic echocardiography for the measurement of AROA. In the new era of transcatheter

77 therapies, the AROA could become an objective imaging biomarker for determining TR severity, and it
78 has the potential to be incorporated in TR grading schemes.

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Conflict of interest

Michito Murayama, Suguru Ishizaka, Keita Sakaguchi, Rion Ando, Hisao Nishino, Sanae Kaga, and Toshihisa Anzai declare that they have no conflict of interest.

Human rights statements and informed consent

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1964 and later versions. Informed consent was obtained from the patient for being included in the study.

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Figure Caption

Fig. 1 (a) PISA radius with Nyquist limit of 27 cm/s on admission. The PISA radius was 9.9 mm. (b) 3D transthoracic echocardiography-derived AROA obtained using Annulus Analysis TV[®] on admission. The AROA was 320 mm². (c) 3D transthoracic echocardiography-derived AROA obtained using multiplanar reconstruction with the manufacturer's software of the Aplio i900 system on admission. The AROA was 376 mm². (d) The PISA radius with Nyquist limit of 27 cm/s post-treatment. The PISA radius was 9.5 mm. (e) 3D transthoracic echocardiography-derived AROA obtained using Annulus Analysis TV[®] post-treatment. The AROA was 40 mm². (f) 3D transthoracic echocardiography-derived AROA obtained using multiplanar reconstruction with the manufacturer's software of the Aplio i900 system post-treatment. The AROA was 60 mm². These images show that the changes in TR severity pre- and post-treatment were difficult to diagnose using the PISA, but could be clearly understood using the AROA, which is a flow-independent parameter. PISA, proximal isovelocity surface area; AROA, anatomical orifice area of the tricuspid valve; ATL, anterior tricuspid leaflet; STL, septal tricuspid leaflet; PTL, posterior tricuspid leaflet

Figure1

