



## Case Report

# Coronary artery tree and myocardial perfusion in patients with tako-tsubo cardiomyopathy: Evaluation with coronary digital subtraction angiography

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Received 23 December 2010; received in revised form 8 June 2011; accepted 26 June 2011

## KEYWORDS

Tako-tsubo cardiomyopathy;  
Myocardial perfusion;  
Digital subtraction angiography

**Summary** Tako-tsubo cardiomyopathy is characterized by transient left ventricular contractile dysfunction. The precise etiology of tako-tsubo cardiomyopathy remains to be elucidated. We performed coronary angiography in two patients with tako-tsubo cardiomyopathy and evaluated the coronary microcirculation by digital subtraction angiography (DSA). In the acute phase of tako-tsubo cardiomyopathy, coronary DSA demonstrated severely reduced perfusion in the apex. Follow-up DSA showed the restoration of normal myocardial perfusion in the apex. Coronary DSA can simultaneously depict the coronary vessels and myocardial perfusion abnormalities. Furthermore, DSA can also show the relationship between the perfusion territory of the coronary arteries and the region of impaired myocardial perfusion. This technique might support the central role of microcirculation disturbance in tako-tsubo cardiomyopathy.

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## Introduction

Tako-tsubo cardiomyopathy is characterized by transient left ventricular dysfunction. The clinical presentation is indistinguishable from acute coronary syndrome, despite angiographically normal coronary arteries. Several

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mechanisms of tako-tsubo cardiomyopathy have been proposed, including catecholamine-induced myocardial stunning, coronary spasm, neurogenic stunned myocardium, and microvascular impairment, however, the precise etiology remains to be elucidated [1].

Intracoronary Doppler guidewire is currently used for evaluation of myocardial perfusion [2]. Myocardial perfusion can also be assessed by angiographic techniques such as TIMI (thrombolysis in myocardial infarction) frame count and TIMI perfusion grade. Previous studies using these methods suggested the presence of impaired myocardial perfusion in the acute phase of tako-tsubo cardiomyopathy [3,4].

Recently, digital subtraction angiography (DSA) has been used to assess myocardial perfusion [5,6]. Myocardial perfusion can be clearly seen on DSA images. To evaluate myocardial perfusion, we performed coronary DSA in patients with tako-tsubo cardiomyopathy.

## Methods

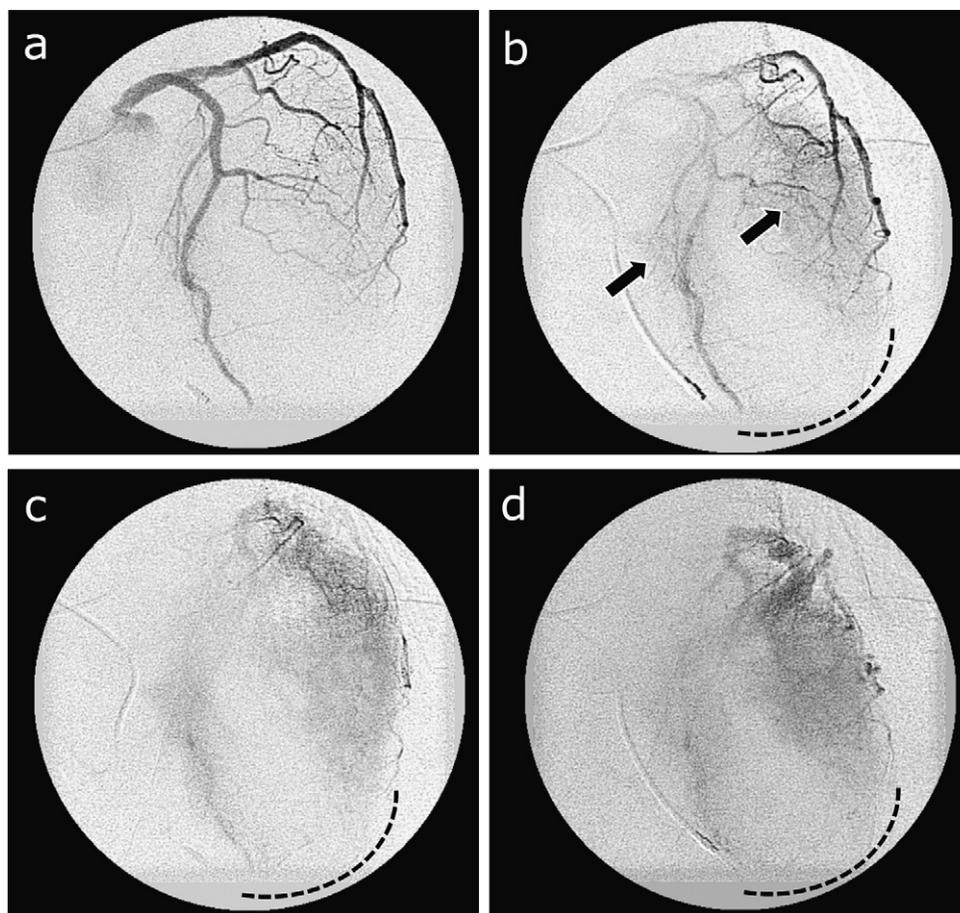
Custom software running on a personal computer was used to process the angiographic images [5]. Our technique consists of four steps. (1) Divide coronary angiographic images into two sets, mask (less-contrast) and contrast sets. (2) Create minimum intensity projection (MinIP) images of mask

and contrast sets. The region of interest (ROI) was detected by subtraction images of both MinIP image. Eliminate vessel area from each image to prevent mis-registration due to contrast. (3) Compare motion patterns to determine best mask. (4) Subtract best mask from each image. Our hand-made software calculates a cross-correlation coefficient of ROI, and determines the adequate mask image for each contrast image by evaluating similarity in the ROI.

## Case presentation

### Case 1

A 91-year-old woman was admitted to our hospital with a history of fainting. She was diagnosed with sick sinus syndrome. Implantation of a permanent cardiac pacemaker was performed under local anesthesia. During the pacemaker implant procedure, systolic blood pressure rose to 200 mmHg. After pacemaker surgery, the patient complained of dyspnea. Her electrocardiogram showed ST-segment elevation in leads I, II, III, aVL, aVF, and V2–6. Transthoracic two-dimensional echocardiography showed severe anteroseptal apical dyskinesia with basal hyperkinesis. The levels of creatine kinase and troponin T were within



**Figure 1** Case 1. Serial images of coronary digital subtraction angiography in acute phase of tako-tsubo cardiomyopathy. Myocardial enhancement was clearly detectable in the basal and mid-portions of the left ventricle (black arrows). On the other hand, myocardial perfusion was severely reduced in the apex area (dashed line area).

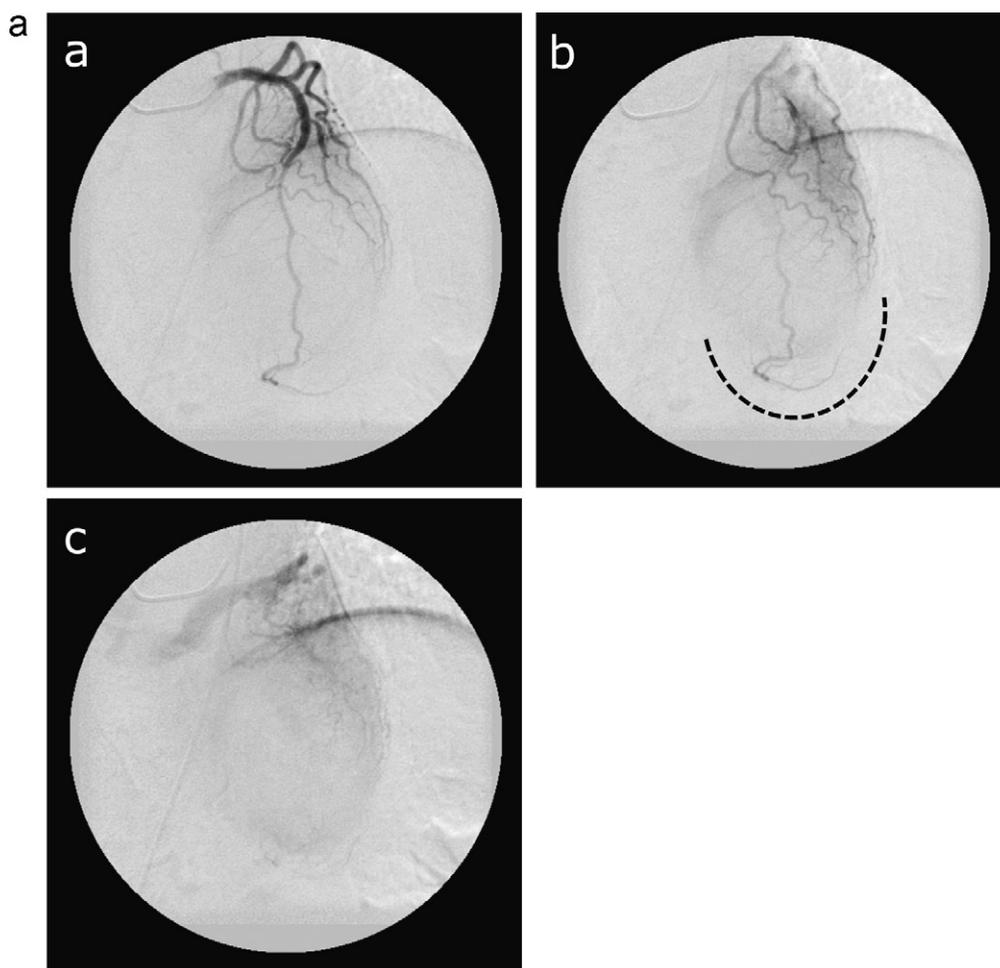
normal limits. Emergency coronary angiography revealed normal epicardial coronary arteries, and apical ballooning was confirmed by left ventriculography. The patient was diagnosed with tako-tsubo cardiomyopathy based on the clinical and laboratory findings.

We performed coronary DSA from conventional coronary angiographic images. In the cranial-left anterior oblique view, coronary DSA demonstrated severely reduced perfusion in the apical area (Fig. 1, see Video, Supplemental Digital Content 1). Twenty-four hours later, her electrocardiogram showed QT prolongation and negative T waves in the precordial leads. Unfortunately, nuclear imaging studies were not available for this patient. The patient had a good clinical course. The left ventricular wall motion abnormality recovered completely after 3 months.

## Case 2

A 70-year-old woman was admitted to our hospital for acute onset chest pain. An electrocardiogram showed ST-segment elevation in leads V2–6. Coronary angiography

revealed no significant stenosis, and left ventriculography showed apical ballooning and akinesis. The patient was diagnosed with tako-tsubo cardiomyopathy based on the clinical findings. Coronary DSA showed severely reduced myocardial perfusion in the apical area (Fig. 2a, see Video, Supplemental Digital Content 2), and the coronary sinus was visualized immediately. Myocardial scintigraphy using <sup>123</sup>I-meta-iodobenzylguanidine (MIBG) showed an uptake defect in the apex. The heart-to-mediastinum ratio was reduced in both the early (1.9; normal values, 1.9–3.7) and delayed images (1.8; normal values, 2.0–3.8). The MIBG washout rate was within the normal range (31%; normal values, 15–44%). These results suggested sympathetic nerve damage in the anterior apical area. Reduced accumulation of <sup>123</sup>I beta-methyliodophenyl pentadecanoic acid (BMIPP) was observed in parallel with the area of reduced MIBG uptake. Three weeks later, two-dimensional echocardiography showed improved LV wall motion. Follow-up DSA showed the restoration of normal myocardial perfusion in the apex (Fig. 2b, see Video, Supplemental Digital Content 3), which exemplified the reversible perfusion defect in tako-tsubo cardiomyopathy. Both <sup>123</sup>I-MIBG and



**Figure 2** Case 2. Serial images of coronary digital subtraction angiography (DSA) in acute phase (a) and chronic phase (b) of tako-tsubo cardiomyopathy. (a) Coronary DSA (the straight cranial view of the left coronary artery) demonstrated reduced myocardial perfusion in the apex area (dashed line area). (b) Follow-up DSA (the right anterior oblique caudal view) displayed restored myocardial perfusion in the apex area.

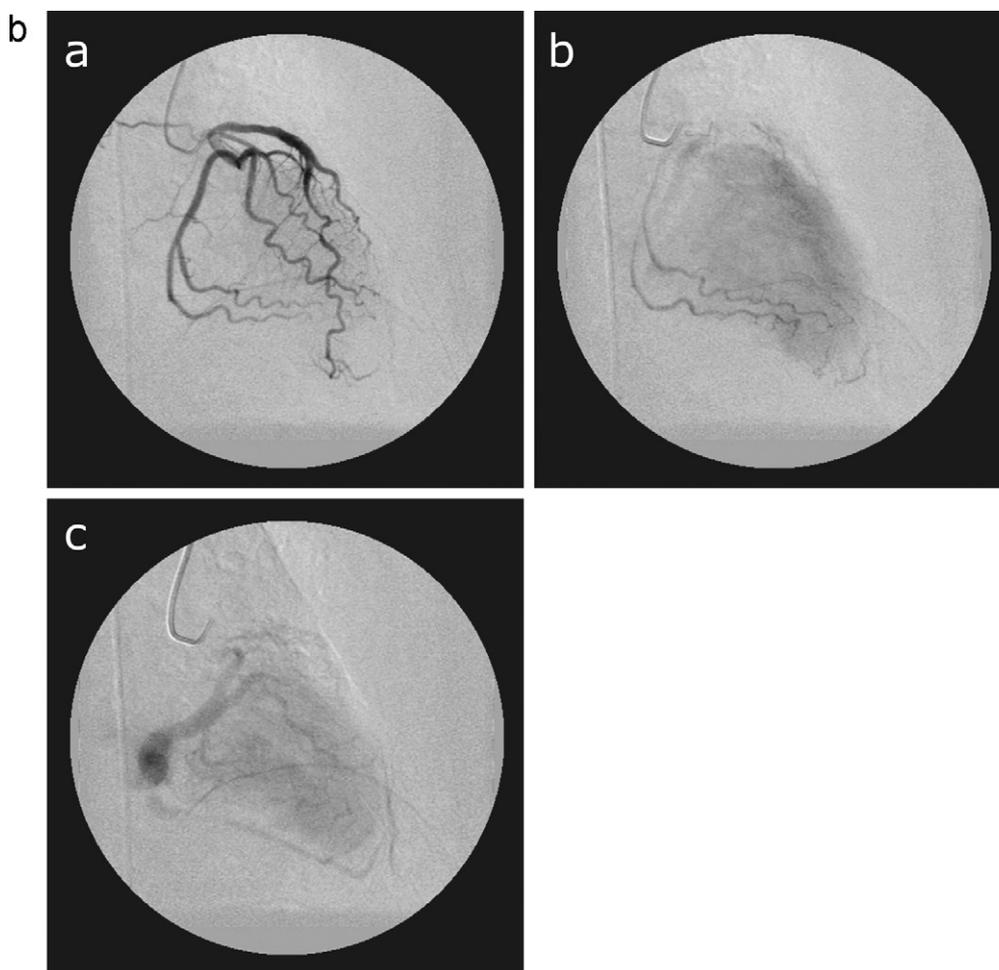


Figure 2 (Continued).

BMIPP scintigraphy did not fully recover after one-month of follow-up.

## Discussion

Tako-tsubo cardiomyopathy is often precipitated by emotional or physical stress, and then also referred to as the Broken Heart Syndrome. An abnormal TIMI perfusion grade can be detected as in at least two thirds of the patients at the time of presentation, and the perfusion grade correlates with the magnitude of troponin elevation and electrocardiographic abnormalities [7]. However, these techniques are not useful in an emergency, because myocardial perfusion SPECT requires an additional examination, and the interobserver agreement of TIMI perfusion grade is not high [8]. Takeda et al. previously reported the utility of coronary DSA for the diagnosis of heart disease in another analytical method [9]. Our paper is the first report that suggests the utility of coronary DSA for the assessment of microcirculation disturbances in tako-tsubo cardiomyopathy. We think that coronary DSA might be useful for the evaluation of myocardial perfusion in an emergency, because conventional coronary angiography can be used to generate DSA images. One of the important advantages of coronary DSA is that this method can demonstrate not only arterial phase

but also capillary and venous phase images. Furthermore, DSA can simultaneously depict coronary vessels and myocardial perfusion abnormalities, and precisely addresses the relationship between the perfusion territory of the coronary arteries and the area of impaired myocardial perfusion. For a limitation of our technique, the impairment of local perfusion cannot be assessed quantitatively. A quantitative assessment of coronary DSA has been tried in several reports [10,11]. Further development of the analytical method is needed.

It remains unclear whether impairment of the coronary microcirculation is a cause or an effect of tako-tsubo cardiomyopathy [12]. Kurisu et al. reported the myocardial metabolism measured by fatty acid was more severely impaired than myocardial perfusion [13]. However, these results might suggest that the coronary microcirculation recovers more rapidly than myocardial metabolism. Coronary DSA might support the central role of microcirculation disturbance in tako-tsubo cardiomyopathy.

## Acknowledgments

Satoru Oishi is an employee of Toshiba Medical Systems Corporation. Parts of this study were presented at the 56th

Scientific Session of Japanese College of Cardiology, Tokyo, Japan, September 8–10, 2008.

## Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at [doi:10.1016/j.jccase.2011.06.008](https://doi.org/10.1016/j.jccase.2011.06.008).

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