Journal of Cardiology Cases 10 (2014) 180–183

Contents lists available at ScienceDirect

Journal of Cardiology Cases

journal homepage: www.elsevier.com/locate/jccase

Case Report

Burn-associated delayed dilated cardiomyopathy evaluated by cardiac PET and SPECT: Report of a case

Reimu Fukui (MD)[a], Hideaki Suzuki (MD, PhD)[b,c,*], Noriko Miyagawa (MD)[c], Tomoyuki Endo (MD)[c,d], Tomohiro Kaneta (MD, PhD)[e], Koichiro Sugimura (MD, PhD, FJCC)[b], Yasuharu Matsumoto (MD, PhD, FJCC)[b], Shoki Takahashi (MD, PhD)[e], Yutaka Kagaya (MD, PhD, FJCC)[a,d], Shigeki Kushimoto (MD, PhD, FJCC)[c], Hiroaki Shimokawa (MD, PhD, FJCC)[b]

[a] Graduate Medical Education Center, Tohoku University Hospital, Sendai, Japan
[b] Department of Cardiovascular Medicine, Tohoku University Graduate School of Medicine, Sendai, Japan
[c] Division of Emergency and Critical Care Medicine, Tohoku University Graduate School of Medicine, Sendai, Japan
[d] Comprehensive Education Center for Community Medicine, Tohoku University Graduate School of Medicine, Sendai, Japan
[e] Department of Diagnostic Radiology, Tohoku University Hospital, Sendai, Japan

ARTICLE INFO

Article history:
Received 4 April 2014
Received in revised form 3 July 2014
Accepted 4 July 2014

Keywords:
Burn injury
Dilated Cardiomyopathy
PET
SPECT
Heart failure

ABSTRACT

Dilated cardiomyopathy is a delayed-onset and rarely reported cardiac complication of burn injury although the mechanism remains unclear. We thus report a case of dilated cardiomyopathy following severe burn injury, in which technetium 99m sestamibi single-photon emission computed tomography (SPECT), iodine-123 beta-methyl-iodophenylpentadecanoic acid SPECT and ^{18}F-fluorodeoxyglucose positron emission tomography (PET) were performed to evaluate the pathophysiologic condition in combination with cardiac catheterization and myocardial biopsy. The cardiac PET and SPECT images showed reduced myocardial blood flow, decreased fatty acid metabolism, and increased glucose utilization in the left ventricular lateral wall in spite of normal coronary angiography, no significant cardiac fibrosis, and inflammatory cell infiltration, which suggests that myocardial ischemia due to microcirculatory disturbance in hypermetabolic state associated with burn injury might be a causative mechanism of dilated cardiomyopathy in this case. A beta blocker, bisoprolol, was successfully introduced in this patient in combination with oral inotropic agents, pimobendan and digitalis after the prolonged use of intravenous dobutamine infusion, which might have been beneficial for this patient with burn-associated dilated cardiomyopathy not only to reduce regional myocardial ischemia but also to attenuate hypermetabolic state after severe burn injury.

<**Learning objective:** Dilated cardiomyopathy complicated with burn injury has been reported to cause a sudden attack of dyspnea and death. This case report suggests that burn-associated dilated cardiomyopathy may be caused by relative myocardial ischemia due to microvascular disturbance in hypermetabolic state associated with burn injuries and can be treated effectively with beta blockers with or without oral inotropic agents.>

Introduction

Severe burn injury results in death without emergent and intensive care and can be complicated with organ failures including the heart [1]. Although dilated cardiomyopathy has been reported as a delayed-onset (42–310 days after the onset of burn injury) and rarely reported cardiac complication of burn injury which causes a sudden attack of dyspnea and death [2–4], the condition is poorly recognized and the pathophysiology remains largely unclear. Cardiac positron emission tomography (PET) and single-photon emission computed tomography (SPECT) are noninvasive techniques to assess myocardial blood flow, fatty acid metabolism, and glucose utilization [5–7]. We thus report a case of dilated cardiomyopathy following severe burn injury, in

* Corresponding author at: Department of Cardiovascular Medicine, Tohoku University Graduate School of Medicine, 1-1 Seiryo, Aoba, Sendai 980-6574, Japan. Tel.: +81 22 717 7153; fax: +81 22 717 7156.
E-mail address: hd.suzuki.1870031@cardio.med.tohoku.ac.jp (H. Suzuki).

http://dx.doi.org/10.1016/j.jccase.2014.07.005
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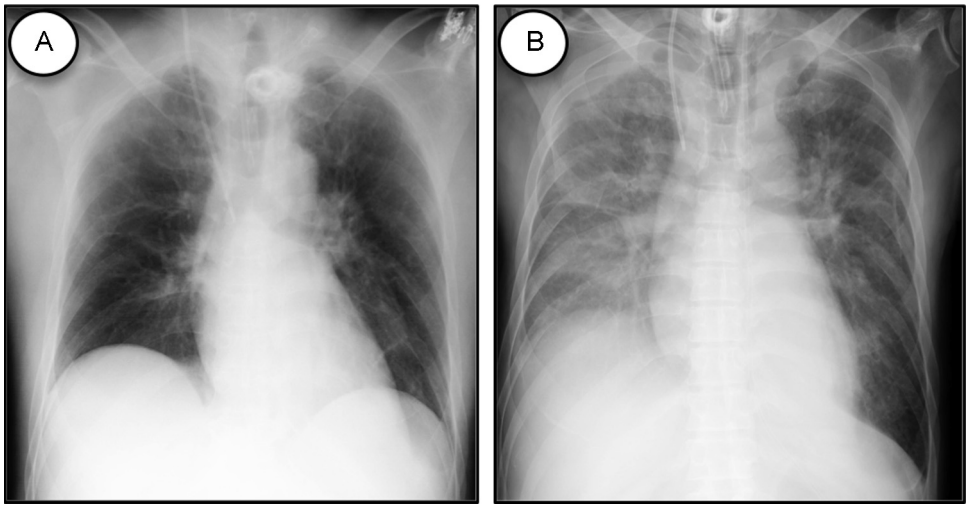

Fig. 1. The chest X-ray on the 1st day (A) and 111th day (B) of admission.

which cardiac PET and SPECT were performed to evaluate the pathophysiologic condition in combination with cardiac catheterization and myocardial biopsy.

Case report

A 51-year-old male was transferred to our hospital for burn injury resulting from a suicide attempt. He had a history of depression but not that of any cardiac diseases. He showed no sign of heart failure on chest X-ray on admission (Fig. 1A). The extent of burn was 60% of his total body surface area. Since inhalation injury was also found, tracheostomy was performed for respiratory care. Burns were treated with a series of debridement and skin-grafting operations. Echocardiography showed preserved left ventricular (LV) ejection fraction of 56% and LV diastolic diameter of 52 mm on the 71st day of admission.

Sudden onset of decrease in arterial oxygen saturation occurred on the 106th day of admission. Chest X-ray showed severe pulmonary infiltrative shadow in both sides (Fig. 1B) and B-type natriuretic peptide level was 1027 pg/ml. Echocardiography showed severe LV global hypokinesis with ejection fraction of 25% and LV diastolic diameter of 52 mm. LV wall was neither edematous nor hyperechoic and pericardial effusion was not identified on echocardiography. Cardiac enzyme levels were normal and ST-segment elevation or depression in electrocardiogram was not observed. The patient was diagnosed as having heart failure and intravenous infusion of dobutamine and milrinone was initiated. However, the intravenous infusion of the inotropes could not be tapered off due to the repetition of the exacerbation of heart failure. Cardiac catheterization including myocardial biopsy was performed on the 189th day of admission while intravenous infusion of dobutamine was continued. These studies showed global LV hypokinesis with ejection fraction of 24% (Fig. 2A and B) and oxygen saturation of mixed venous blood flow (SvO_2) of 55.7% in spite of no significant coronary artery stenosis (Fig. 2C and D) and preserved cardiac index of 2.86 and 3.36 l/min/m^2 measured by thermo- and Fick's methods, respectively. Pulmonary artery pressure, pulmonary capillary wedge pressure and LV end-diastolic pressure were 21/9 mmHg, 7 mmHg, and 17 mmHg, respectively. No significant intercellular fibrosis and inflammatory cell infiltration were observed in myocardial biopsy samples obtained from the interventricular septum. Intravenous infusion of inotropes was able to be ceased on the 224th day of admission and bisoprolol was successfully introduced after the initiation of the oral administration of pimobendan and digitalis. His symptoms were gradually relieved and he was transferred to another hospital for rehabilitation on the 310th day of admission. Follow-up echocardiography on the 401st day of admission showed that LV systolic function was recovered with an ejection fraction of 49% and LV end-diastolic diameter of 40 mm.

We performed technetium 99m sestamibi (^{99m}Tc-MIBI) SPECT, iodine-123 beta-methyl-iodophenylpentadecanoic acid SPECT and ^{18}F-fluorodeoxyglucose (^{18}F-FDG) PET under fasting conditions to assess the cause of heart failure on the 244th day, 239th day, and 241st day of admission, respectively. Although no significant stenosis was observed in coronary angiography, ^{99m}Tc-MIBI–SPECT demonstrated a decrease in myocardial blood flow in the LV lateral wall (Fig. 3A), where decreased fatty acid metabolism and increased glucose utilization were observed in the area using BMIPP SPECT and ^{18}F-FDG-PET, respectively (Fig. 3B and C). These findings indicate that myocardial ischemia may be associated with the cause of dilated cardiomyopathy in this case.

Discussion

To the best of our knowledge, this is the first case that burn-associated dilated cardiomyopathy was investigated using cardiac PET and SPECT. Although neither significant coronary stenosis, cardiac fibrosis, nor inflammatory-cell infiltration was found in coronary angiography and myocardial biopsy, reduced myocardial blood flow, decreased fatty acid metabolism, and increased glucose utilization were observed in this case. These findings have also been reported in some cases of idiopathic dilated cardiomyopathy [5–7] and may be caused by endothelial dysfunction and/or decreased angiogenesis [8]. Reduced myocardial blood flow and coronary endothelial dysfunction were also observed in animal models of burn injuries [9,10]. Therefore, relative myocardial ischemia due to microcirculatory disturbance in hypermetabolic state might have caused burn-associated dilated cardiomyopathy in this case.

LV systolic function was globally decreased although decreased myocardial blood flow and fatty acid metabolism and increased glucose utilization were localized to the lateral wall in this case. Such a discrepancy has also been observed in the past reports of idiopathic dilated cardiomyopathy [5–7]. Histological analysis and cardiac magnetic resonance imaging, respectively, showed patchy and variable fibrosis and late gadolinium enhancement in the area with decrease in myocardial blood flow and glucose utilization in idiopathic dilated cardiomyopathy [7,11]. These findings suggest

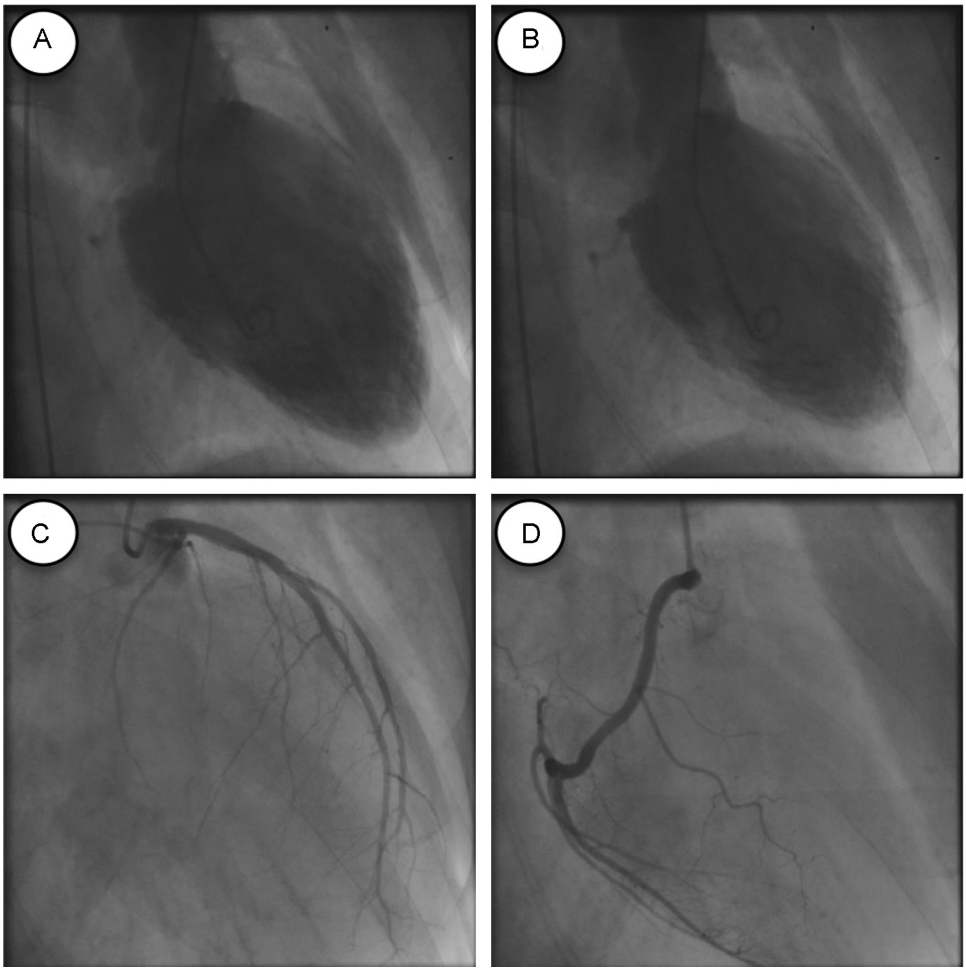

Fig. 2. The end-diastolic (A) and end-systolic (B) phases of the left ventricle and the left (C) and right (D) coronary artery shown by the cardiac catheterization on the 189th day of admission.

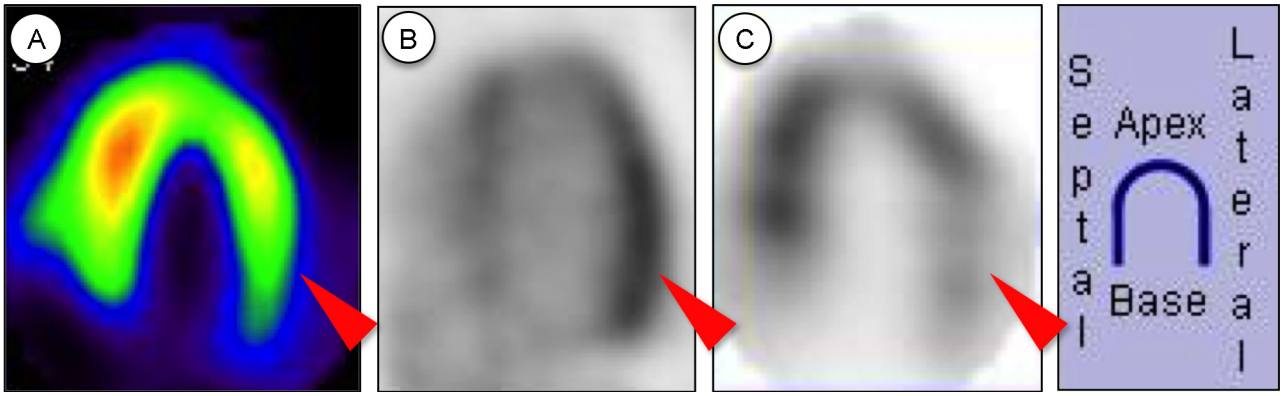

Fig. 3. Technetium 99m sestamibi single-photon emission computed tomography (SPECT) (A), ^{18}F-fluorodeoxyglucose positron emission tomography (B) and iodine-123 beta-methyl-iodophenylpentadecanoic acid SPECT (C) on the 244th day, 239th day, and 241st day of admission, respectively.

that the abnormal perfusion and metabolism in idiopathic dilated cardiomyopathy may reflect the process of cardiac damage. On the other hand, global myocardial blood flow is relatively more homogenous and local defect of myocardial blood flow is moderate in idiopathic dilated cardiomyopathy compared to ischemic heart disease [6], which can explain that regional abnormality of cardiac metabolism and myocardial blood flow is not associated with corresponding wall motion abnormality.

Several animal studies showed acute impairment of cardiac contraction as early as 2 h postburn, which gradually resolved at 48–72 h [12]. The early reversibility indicated that acute cardiac dysfunction occurred in burn injury. In contrast, dilated cardiomyopathy was delayed-onset (42–310 days after the onset of burn injury) [2–4] and required a year to recover in this case. Myocardial microvascular remodeling has been reported to occur in patients with idiopathic dilated cardiomyopathy [13] and to be induced by

tumor necrosis factor-alpha [14], which is increased in patients with burn injury [15]. Therefore, an anatomical basis such as myocardial microvascular remodeling might explain the delayed-onset and slow recovery of dilated cardiomyopathy in burn injury.

It was difficult to taper off intravenous inotropes in this patient without the administration of oral inotropic agents, which was probably related to the low SvO_2 despite preserved cardiac index. Long-term treatment with beta blockers has been shown to ameliorate impaired regional myocardial blood flow in idiopathic dilated cardiomyopathy [16], and may attenuate hypermetabolic response induced by catecholamine surge in burn injury [17], and thus may also be effective for burn-associated dilated cardiomyopathy. Burn injury elicits high cardiac output [18] that probably compensates for the hypermetabolic state in burn injury [19]. Therefore, inotropic agents may be necessary to effectively support this hypermetabolic condition, and combination therapy with a beta blocker and inotropic agents should be considered in burn-associated dilated cardiomyopathy.

In conclusion, this case suggests that burn-associated dilated cardiomyopathy may be caused by relative myocardial ischemia due to microvascular disturbance in the hypermetabolic state associated with burn injuries and can be treated effectively with beta blockers with or without oral inotropic agents.

Conflict of interest

The authors declare no conflict of interest.

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