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Controlled earlier reperfusion for brain ischemia caused by acute type A aortic dissection

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Abstract

Brain malperfusion caused by acute type A aortic dissection is a life threatening situation, which should be relieved as early as possible with minimal reperfusion injury prior to aortic repair. The patient was 72-year-old female with acute type A aortic dissection. She was referred to us 2.5 hours after onset of chest pain and was unconscious with a complete left paralysis. The true lumen of internal carotid artery was severely stenosed. A simple bypass circuit was installed from the femoral artery to the true lumen of the right common carotid artery, which consisted with a roller pump and cold bath for blood cooling. Regional oxygen saturation of the right frontal brain raised immediately after initiation of the bypass and she underwent emergency ascending-hemiarch replacement. Post-operative course was complicated with a right brain stroke, however, brain computed tomography and magnetic resonance imaging disclosed minimum brain edema. She was discharged on foot on 35th postoperative day and walking with a stick after seven month.

Introduction

Emergent surgery of acute aortic dissection remains controversial in patients who have complicated with cerebral malperfusion because of its high mortality and cerebral morbidity (1-3). It is generally accepted that early reperfusion is extremely important to reduce brain ischemic insult, and several techniques have been reported to save brain integrity(4;5). However, all of them were applied during the aortic operation and ischemic insult was continued until the reperfusion of the carotid artery was established.

We reported a preoperative strategy to reduce not only the brain warm ischemia but also reperfusion injury using a low flow perfusion and blood tepid cooling system.

Material and Methods

A 72-year-old female complained a sudden onset of the chest and back pain and manifested a left paralysis with an abrupt onset of consciousness disorder scored 12 according to the Glasgow Coma Scale. When she was transported to us, the consciousness level was deteriorated and she was intubated, and was comatous Glasgow Coma Scale 7. A chest computed tomography (CT) showed a Stanford type A acute aortic dissection involving all three arch branches. Duplex ultrasonography showed a scarce blood flow of the right common carotid artery (CCA) compressed by enlarged false lumen. We considered that the brain ischemia was progressing and should be relieved as early as possible prior to the central aortic operation. The femoral artery and the right common carotid artery were exposed. A simple bypass circuit (Poly-vinyl Prolight 4.5mm tube; Senko, Tokyo, Japan)

was applied connecting with each dialysis catheters (Blood Access UK-Catheter Kit diameter 2.2mm; Unitica, Aichi, Japan) from the femoral artery to the true lumen of the right common carotid artery using a roller pump (HAD 11; Senko, Tokyo, Japan). The bypass circuit was cooled in a tepid bath at 30 °C (Fig. 1). During the procedure, brain oxygenation (rSO₂) was monitored by near-infrared spectroscopy (INVOS 4100; Somanetics, Troy, MI). Initial rSO₂ monitored on the right and left forehead was 17% and 38 %, respectively. A pump flow of 90 ml/min (1.8 ml/kg/min) using the tepid blood cooling system increased the right rSO₂ up to 35% with no laterality (Fig. 2). Duration of reperfusion system was 2.0 hours. Immediately after stabilizing the brain circulation, she was transferred to the operation room and ascending-hemiarch replacement using the selective antegrade cerebral perfusion (SCP) under deep hypothermia was completed. When SCP was initiated, the carotid artery perfusion was stopped and the carotid artery cannula was removed. Postoperative course was uneventful, she woke up on the 1st postoperative day and extubated next day. She remained to be hemi-paretic, however, she was able to walk and discharged on 35th postoperative day. Although serial brain CT scans and magnetic resonance imaging (MRI) disclosed multiple strokes in right cerebral hemisphere, there was a minimum brain edema (Fig. 3). It is seven month after the operation, she can walk with a stick.

Comment

Brain malperfusion caused by acute type A aortic dissection is one of tragedies and usually manifests as a transient or permanent ischemic neurological deficit. On-going brain ischemia caused by the carotid artery dissection with cessation of the blood flow should be relieved as early as possible not only be-

cause to prevent brain ischemia but also to alleviate that reperfusion injury of the brain, which eventually ensues as irreversible brain edema.

In the majority of cases, aortic repair in the operation theatre has been selected to solve this problem. However, several hours are required to obtain the normal brain blood flow through true lumen of the carotid artery and this strategy is usually too late to achieve satisfactory outcome of the brain. A few successful maneuvers to reduce the brain damage has been reported (4;5); but there was not a single report to demonstrate that the on-going brain warm ischemic insult was relieved preoperatively.

We have developed a simple bypass circuit to save the brain prior to the aortic repair in the emergency room. The brain saving system was based on two concepts. One is to accomplish the earlier reperfusion when the patient was recognized to have a serious on-going brain ischemia. In the present case, we could reperfuse the right CCA within 3 hour after onset of neurological symptom and the rSO₂ increased dramatically soon after CCA reperfusion. Another concept is to minimize the reperfusion injury. The optimal reperfusion flow and blood temperature remain unclear. It's believed that higher flow reperfusion causes more brain edema, on the other hand, lower flow results in the lack of brain perfusion (6). In the present case, the reperfusion flow of 1.8 ml/kg/min was determined according to the recovery of near-infrared spectroscopy. We retrospectively investigated that the reperfusion flow was satisfactory since the right rSO₂ raised up to 35% with no laterality and a minimum brain edema documented by serial CT scans and MRI. The optimal reperfusion flow at tepid blood temperature (30°C) was set at between half and one-thirds of the normal common carotid artery flow of 4-6 ml/kg/min under normothermia (36-37°C).

Further investigation is mandatory to pursue the optimal blood flow or temperature, but we believe that our simple brain saving system which was applied prior to aortic repair has a great advantage to reduce brain warm ischemia-reperfusion injury cause by complicated acute aortic dissection.

Figure Legends

Figure 1. A simple bypass circuit was established from the femoral artery to the true lumen of the right common carotid artery in emergent room.

T: True lumen of aortic dissection, F: False lumen of aortic dissection,

Rt CCA: The right common carotid artery, Rt FA: The right femoral artery

Figure 2. Serial change of rSO₂ during the procedure.

CRS: Cerebral reperfusion system, CPB: Cardiopulmonary bypass, SCP: Selective cerebral perfusion.

Figure 3. Serial brain CT scans and MRI showed large right cerebral infarctions, however, brain edema was minimized. POD: Postoperative day

All abbreviations list

CCA: Common carotid artery

CPB: Cardiopulmonary bypass

CRS: Cerebral reperfusion system

CT: Computed tomography

MRI: Magnetic resonance imaging

POD: Postoperative day

rSO₂: Brain oxygenation

Rt CCA: The right common carotid artery

Rt FA: The right femoral artery

SCP: The selective antegrade cerebral perfusion

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Figure 1.

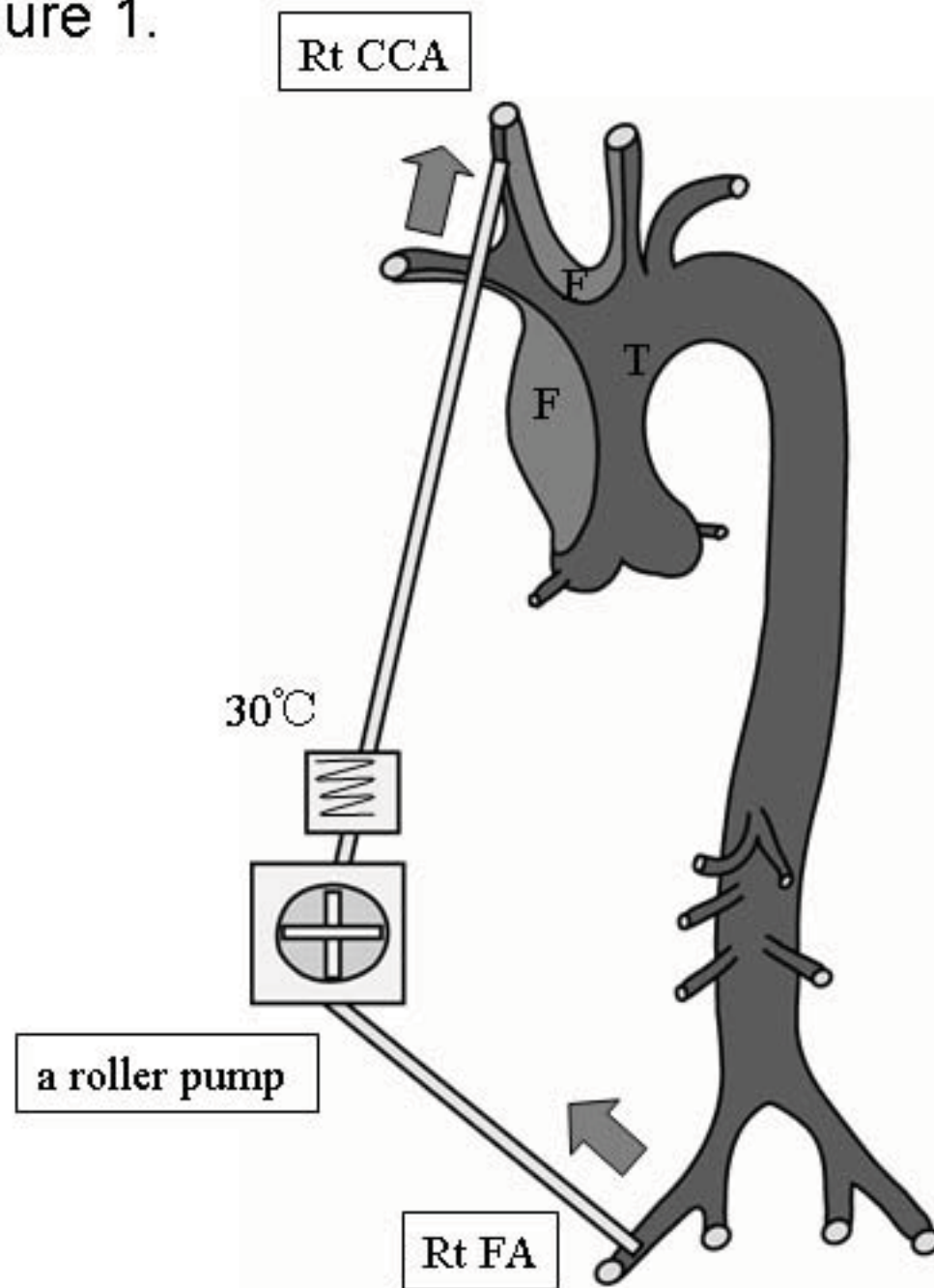


Figure 2.

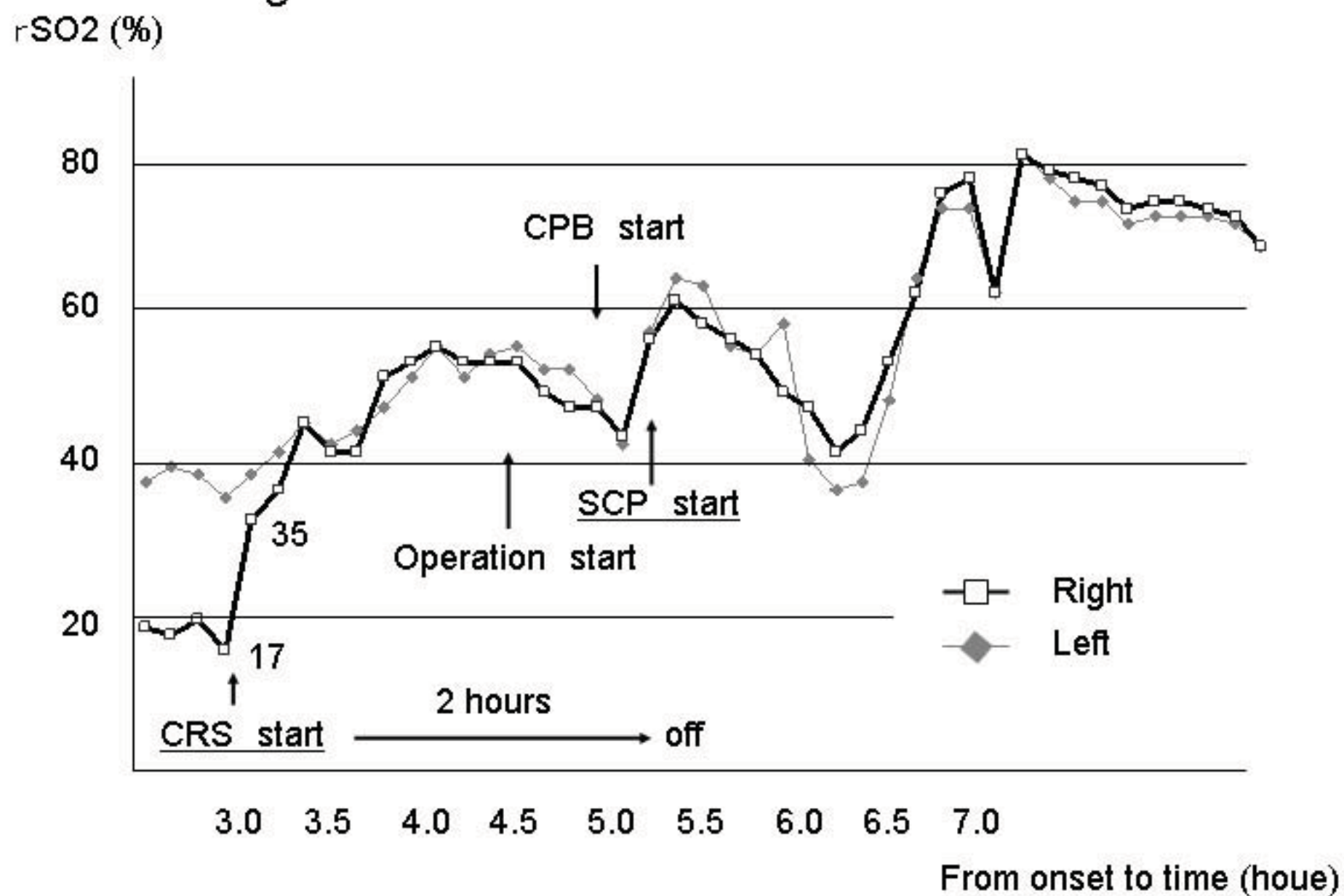
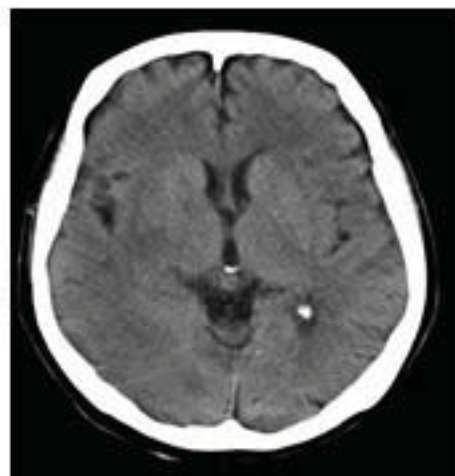
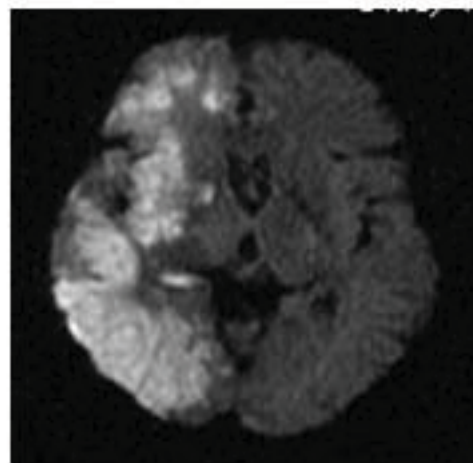


Figure 3.

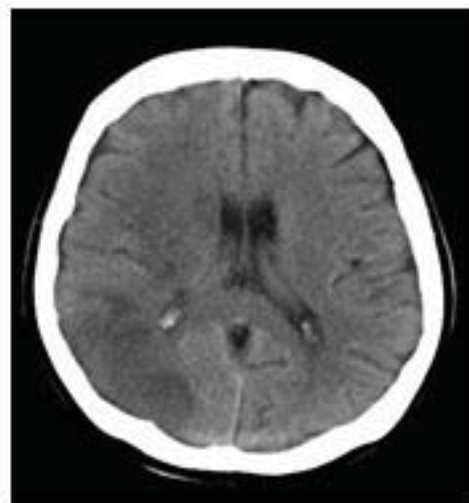
POD #1



POD #3



POD #5



POD #20

