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Successful management of massive anterior-middle cerebral artery territory stroke with catheter-based heat exchange system

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Case Report

ABSTRACT

Elevated temperature is commonly accompanied with severe neurological damage and its management is the key for improving the outcome. Herein we report a 77-year-old man who presented with altered consciousness and left hemiplegia at awakening. The magnetic resonance image on arrival showed right internal carotid artery occlusion and massive completed infarction in anterior and middle cerebral artery territories. He underwent temperature management with catheter-based heat exchange system targeting at 36 degrees Celsius of core temperature for 7 days by local anesthesia. The target temperature was obtained in 4 hours from installation. The core temperature was stably maintained without shivering, discomfort or other adverse effects. The brain edema was not as severe as decompressive craniectomy was required. He gradually recovered consciousness and discharged to the rehabilitation facility with left hemiplegia in modified Rankin Scale of 4. Catheter-based heat exchange enables to acquire target temperature automatically in a short time and could minimize the brain edema after brain damage with safety and feasibility.

Keywords: Stroke, Brain edema, Therapeutic hypothermia, Catheter-Based heat exchange system, Intravascular temperature management

INTRODUCTION

Stroke is one of the leading causes of death and disabilities. The degree of disability largely depends on the infarcted size. Massive cerebral infarction develops space-occupying brain edema with subsequent elevated intracranial pressure, and brain herniation. Thus it has poor, and often fatal, outcome [1]. On the other hand, fever is commonly accompanied with such neurologically critical conditions and itself worsens the neuronal damage and brain edema [2,3]. For these devastating massive infarction, temperature management is the key for preventing the extension of brain edema and improving outcome. Recently, the new device of catheter-based heat exchange system has become available in clinical situation [4]. Herein we report the severe stroke patient who was successfully treated with intravascular temperature management (IVTM) using this new device and avoid the brain herniation without hemicraniectomy.

CASE DESCRIPTION

A 77-year-old man presented with altered consciousness and left hemiplegia at awakening. On arrival, he had consciousness disturbance of Glasgow Coma Scale of 11 (E3V3M5), conjugate deviation to the right, and left hemiplegia. The initial NIHSS score on admission was 18. The magnetic resonance image showed right internal carotid artery occlusion and massive completed infarction in atrial fibrillation and the diagnosis of cardiogenic embolism was made. He was excluded from reperfusion therapy because of the completed infarction with unknown onset and was brought to the stroke care unit. Since massive brain edema was expected, the catheter-based heat exchange system, ThermoGuard/ CoolLine (Asahi Kasei Zoll Medical, Tokyo, Japan) was installed. To be brief, ThermoGuard is an external heat-exchanger and control unit, and CoolLine is an internal heat exchange catheter with water circulation balloons placed into inferior vena cava via femoral vein. ThermoGuard continuously monitors core temperature through a urethral catheter with a thermo- sensor. Depending on the input, the device regulates the body temperature by changing the temperature and speed of the circulating coolant. The target temperature and the cooling rate which physicians set are obtained automatically [4]. In this patient, the initial axillary and core temperature were 37.2 and 37.9 degrees Celsius, respectively. He underwent IVTM with the device at the target core temperature of 36.0 degrees Celsius on rapid cooling mode, and it was maintained for 7 days by local anesthesia, in addition to conventional medical therapy including hyperosmolar and anti-inflammatory agents. The target temperature was obtained in first 4 hours (Figure 2) and was stably maintained without shivering, discomfort or other adverse effects through the treatment period. He was not sedated and stayed responsive through the course. In follow-up CT scan, the expansion of brain edema was limited and not as severe as decompressive craniectomy was required (Figure 1 D-F). After the 7-day cooling 2). He was discharged to the rehabilitation facility in totally conscious state with remaining left hemiparesis in modified Rankin Scale of 4 (unable to attend to own bodily needs without assistance, and unable to walk unassisted).

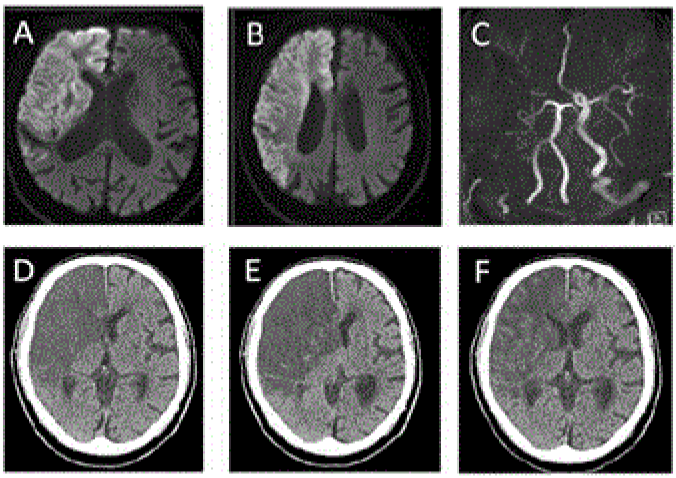

Figure 1. Clinical imaging of massive cerebral infarction A-C: Diffusion Weighted Image of initial MRI. Right internal carotid artery occlusion and completed infarction in anterior and middle cerebral artery territories were observed. D-F: Non-contrast CT scans taken on Day1 (D), Day3 (E), and Day14 (F). Expansion of brain edema was minimized by intravascular temperature management.

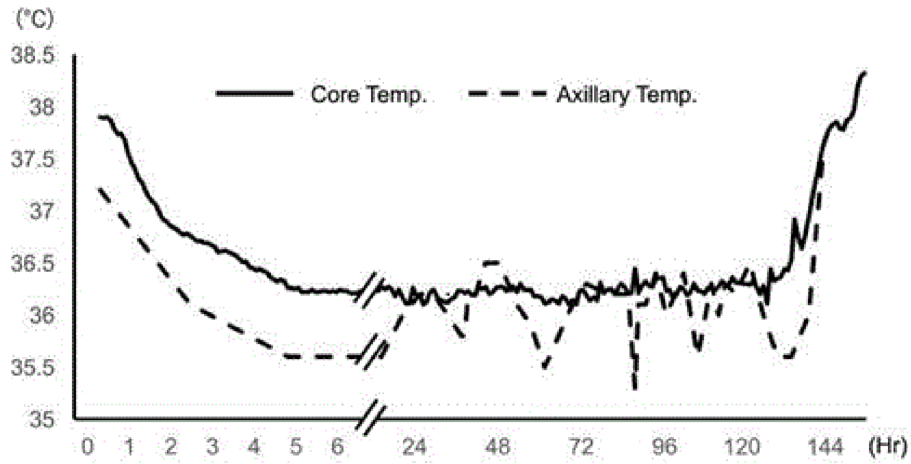

Figure 2. Time course of axillary and core temperature. Target temperature was obtained in 4 hours after installation and maintained stably during the cooling period. Withdraw of cooling was taken over 24 hours.

DISCUSSION

Large vessel occlusion leads a massive stroke and its outcome is generally poor [5]. Reperfusion therapy such as thrombolysis or thrombectomy has recently emerged as a standard therapy for patient in a hyperacute stage, although only limited number (~10%) of patients can receive such treatments [6-8]. For the patients who are not eligible for or unresponsive to reperfusion therapy, complete middle cerebral artery (MCA) territory infarction develops space-occupying brain edema with subsequent elevated intracranial pressure and herniation, and has poor, and often fatal, outcome [1]. The mortality rate reaches 18% with decompressive hemicraniectomy and 53% without it [9]. Thus, it has been described as “malignant” MCA infarction. The outcome of combined anterior cerebral artery (ACA) and MCA infarction, labeled “carotid-T occlusion”, was even worse [10].

Fever is commonly accompanied with such neurologically critical conditions. The half of the cause accounts for infectious, and the others are caused by disturbed central thermoregulation [11]. Whichever the reason is central or infectious, fever itself worsens the neuronal damage and brain the extension of brain edema and improving outcome. Several animal studies have revealed that mild hypothermia can reduce the infarct volume [12]. The precise mechanism of therapeutic hypothermia is not simple and fully understood yet. However, cooling effects against neural damage are through various cell death pathway, such as excitotoxicity, apoptosis, inflammation, and free radical production [13]. Although many experimental animal studies have shown robust neuroprotective effect, clinical benefit of temperature management is still in controversy. From the clinical aspect, surface cooling has non-negligible difficulty in temperature maintenance and patient discomfort, which sometimes results in systemic shivering and requires discontinuation.

To overcome these difficulties, IVTM using catheter-based heat exchange system has been developed and become available in clinical settings [4]. IVTM substantially reduces patient discomfort and enables easy operation. Physicians only set the target temperature and cooling rate. Once those parameters are set, the appropriate temperature is rapidly obtained and maintained automatically. In this case, the device was installed just after the admission. It reached to target temperature in 4 hours from installation, and it was stably maintained automatically (Figure 2). The largest study of IVTM reported adverse effects of infections (34%), pneumonia (20%), and thrombosis (3%), although they are not significant compared with controls [4]. Our patient did not experience any of these. Since the affected hemisphere was in non-dominant side, herecovered consciousness with preserved language ability, except for hemiparesis.

To date, several clinical trials for ischemic stroke using IVTM have failed to show significant superiority in clinical outcome [14-17]. This can be probably because of the widened inclusion criteria or strict setting of primary endpoints for severe stroke. We consider IVTM as an effective tool especially for massive stroke which is expected large brain edema with mass effect. IVTM is expected to become widespread with its advantage of safety and feasibility in minimizing brain edema.

CONCLUSION

We report the successful treatment of massive stroke using IVTM. Installation of IVTM is simple, and target temperature are obtained in short time, and maintained automatically. It is expected to become widespread with its advantage of safety and feasibility.

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