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A case of traumatic cardiopulmonary arrest with good neurological outcome predicted by amplitude-integrated electroencephalogram

Ko Harada*, Kohei Tsukahara, Tetsuya Yumoto, Yasuaki Yamakawa, Atsuyoshi Iida, Hiromichi Naito, Atsunori Nakao

Department of Emergency and Critical Care Medicine, Okayama University Graduate School of Medicine Dentistry and Pharmaceutical Sciences, 2-5-1 Shikata-cho, Kitaku, Okayama 700-8558, Japan

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ABSTRACT

INTRODUCTION: Traumatic cardiopulmonary arrest has a very high mortality, and survival of patients with this condition without neurological disability is rare.

PRESENTATION OF CASE: We herein report a case of traumatic cardiopulmonary arrest secondary to accidental amputation of the left lower leg that was successfully treated without any higher brain dysfunction. Although the long duration of cardiopulmonary arrest in this patient suggested hypoxic ischemic encephalopathy, amplitude-integrated electroencephalogram showed normal findings.

DISCUSSION: This system may help intensivists evaluate the neurological conditions of patients with suspected hypoxic ischemic encephalopathy in the early stage of the clinical course and may assist in guiding therapeutic interventions.

CONCLUSION: Our case supports the usefulness of neurological monitoring using amplitude-integrated electroencephalogram.

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1. Introduction

Cardiopulmonary arrest (CPA) secondary to traumatic injury has a very high mortality, with a 2.2% overall survival rate [1]. Among those survivors, neurological disability is common, being absent in only 0.8% of those suffering from traumatic CPA [1]. However, predicting outcomes after hypoxic ischemic events including CPA still remains challenging for intensivists and emergency physicians [2,3]. We herein report a case of an out-of-hospital traumatic CPA due to hypovolemia that was successfully treated without any higher brain dysfunction in which neurological outcome could be evaluated using amplitude-integrated electroencephalography (aEEG). aEEG is a bedside neurophysiology tool that uses a limited number of channels to record raw EEG signal. Due to its ease of application and interpretation, aEEG has been widely used in these decades in the intensive care medicine. Sharing our experience may emphasize the importance of aEEG in the treatment of traumatic/hemorrhagic CPA. Our report has been reported in line with the SCARE criteria [4].

2. Presentation of case

A 65-year-old man was accidentally injured while driving his cultivator. His left lower leg was completely cut off by the cultivator blades. When the emergency service arrived, his heart rate was 130 beats per minute with weak pulse on the radial artery. During transport, the patient deteriorated and was noted to have cardiopulmonary arrest three minutes before arriving at the emergency room, and cardiopulmonary resuscitation was performed in the ambulance. He arrived at the emergency room 42 min after the initial notification.

On arrival, the patient was unresponsive with absent respiratory movement. Carotid and femoral pulses are not palpable and electrocardiogram showed pulseless electrical activity. Intraosseous access in right lower leg immediately and two intravenous lines in both arms were placed and tracheal intubation was performed. Massive fluid resuscitation and blood transfusion was initiated, and adrenaline 1 mg was administered three times every four minutes. Since active bleeding from the left popliteal artery was noted in spite of pneumatic tourniquet for hemostasis, his left popliteal artery was immediately clamped by forceps (Fig. 1A, B). Return of spontaneous circulation (ROSC) was achieved in 21 min. Heart rate was 110 beats per minute and regular and blood pressure was 70/50 mmHg. No inotropic support to maintain the circulation was administered. The patient was still unconscious with a Glasgow Coma Scale (GCS) score of 3 (E1VTM1).

* Corresponding author.

E-mail address: me422084@okayama-u.ac.jp (K. Harada).

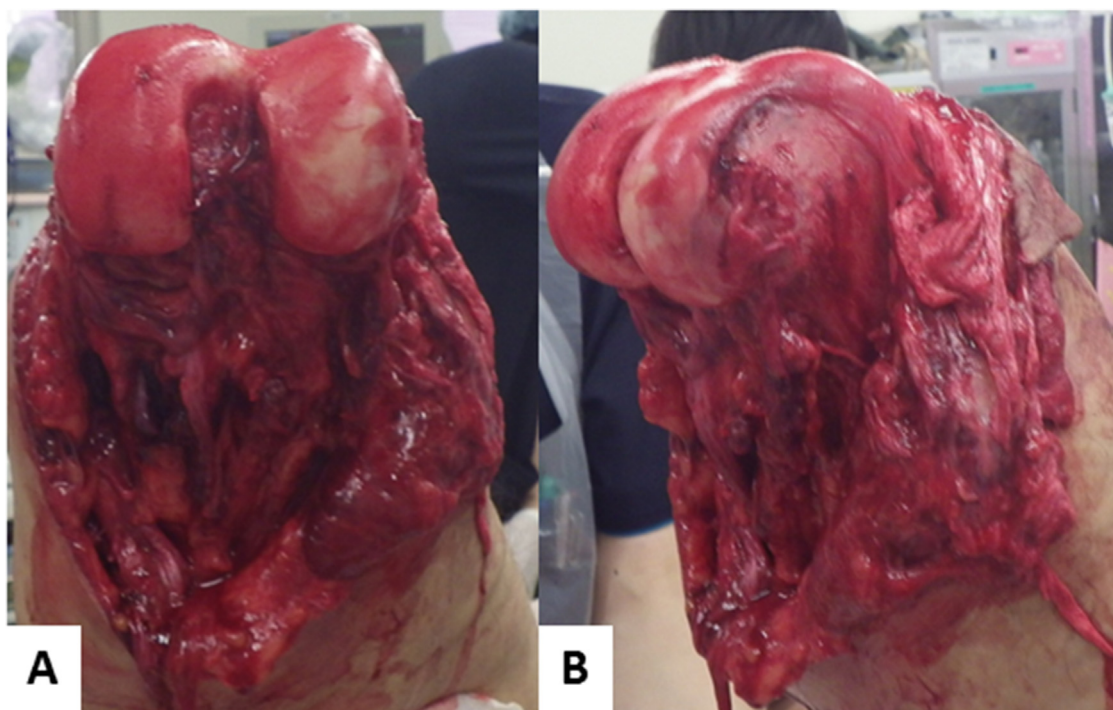


Fig 1. The patient's left lower leg was amputated at the knee joint and there was bleeding from the left popliteal artery in response to chest compression.

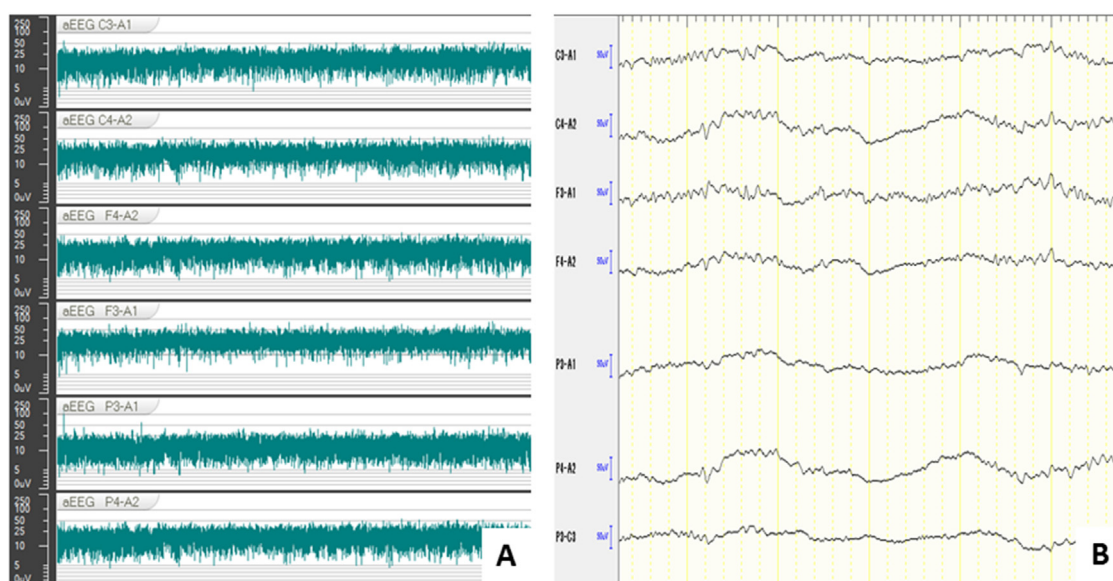


Fig. 2. Eight hours after arrival, amplitude-integrated electroencephalogram was obtained and demonstrated a continuous normal voltage (CNV) pattern. CNV aEEG levels were $>5 \mu V$ (aEEG minimum) and $>10 \mu V$ (aEEG maximum) (Fig. 2a). Original EEG showed 6–10 Hz wave and no abnormal wave (Fig. 2b).

without any sedative medication. Both the left and right pupils were 7.0 mm and did not respond to light. We administered antibiotics, tetanus immunoglobulin and tetanus toxoid. Computed tomography revealed no brain oedema or no other injury. Laboratory findings at presentation revealed the following values: white blood cells $8450/\mu L$, hemoglobin 7.2 g/dL, platelets $6.4 \times 10^4/\mu L$, aspartate aminotransferase (AST) 1250 U/L, creatine kinase (CK) 780 U/L, myoglobin 16,900 ng/mL, and creatinine 1.06 mg/dL. Arterial blood gas tests showed pH 7.020, pCO_2 21.4 mmHg, bicarbonate 5.3 mmol/L, and lactate 18 mmol/L. The patient was then transferred to the emergency intensive care unit. Eight hours after

arrival, aEEG demonstrated a normal pattern of continuous normal voltage (CNV) associated with normal light reflex (Fig. 2).

His clinical course and laboratory findings are shown in Fig. 3. On day 2, amputation stump plasty was performed on his left leg. On day 3, his serum AST and CK levels were noted to be markedly increased to 11,031 U/L and 5137 U/L, respectively, suggesting rhabdomyolysis. Since his serum creatinine level has risen to 4.85 mg/dL due to acute kidney injury, continuous hemodiafiltration (CHDF) was administered from day 5 to day 10. He recovered consciousness with a GCS score of 11 (E4VTM6) on day 5. On day 10, the patient was extubated. The patient was transferred to another hospital on day 25 for further rehabilitation. At six months after

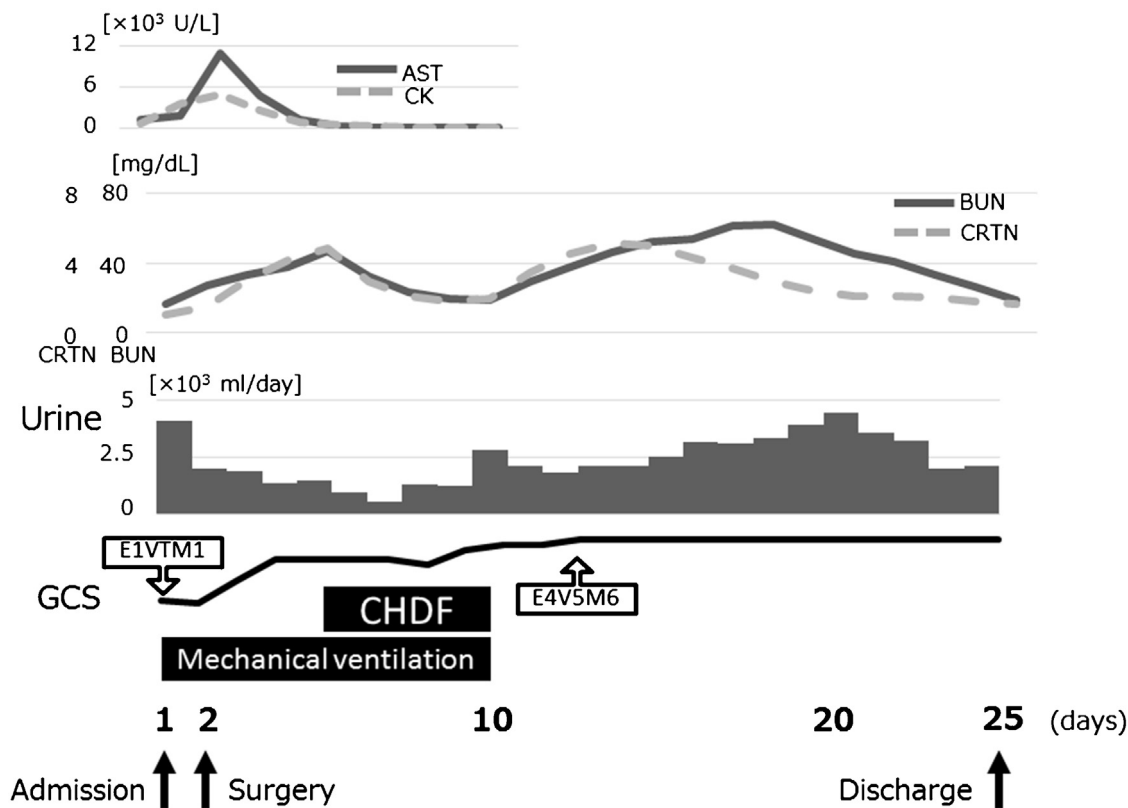


Fig. 3. The patient's clinical course and transition of Glasgow Coma Scale (GCS) and laboratory data, including aspartate aminotransferase (AST), creatine kinase (CK), blood urea nitrogen (BUN), creatinine (CRTN), and urinary output are shown. On day 2, amputation stump plasty of his left leg was performed. Continuous hemodiafiltration (CHDF) was done from day 5 to day 10. On day 10, the patient was extubated.

discharge from our hospital, the patient was able to live daily life independently using leg prosthesis. His neurological outcome is good with cerebral performance category 1 [5].

3. Discussion

aEEG, which is generated from simplified EEG montage with a limited number of raw EEG curves, is easy to read and has been widely used in neonatal hypoxic ischemic encephalopathy for prognostication [6–8]. Recently, aEEG has been increasingly applied for adult patients, especially those with post cardiac arrest syndrome [9]. aEEG is available at the bedside, even if a patient is sedated or intubated. In addition, interpretation of collected data is much simpler than that of other tools such as continuous electroencephalogram, since the artifact derived from other monitors can be filtered and rectified particularly in the intensive care unit.

Oh et al. presented data from subjects successfully resuscitated from cardiac arrest receiving hypothermia therapy and evaluated the prognostic value of aEEG. They reported that the time to normal trace within 24 h after ROSC was associated with good neurological outcome [10]. In our case, aEEG obtained eight hours after ROSC demonstrated CNV and the patient finally recovered without higher brain dysfunction. Our case implied that aEEG might be a useful tool to predict neurological prognosis in the early treatment stage, helping clinicians to start therapeutic intervention.

To our knowledge, there have been no previous case reports of the use of aEEG in the setting of ROSC after traumatic CPA. Traumatic CPA is unique because it often requires invasive therapeutic interventions such as surgical hemostasis, pericardiocentesis, or tracheotomy [1]. In our case, we were thus able to perform further surgery such as amputation stump plasty and CHDF for six days during the hospitalization. Considering that a large majority

of patients with traumatic CPA have poor neurological outcomes, normal aEEG findings at initial presentation encouraged us to start invasive and intensive treatments, in spite of the lack of evidence that such monitoring improves outcome.

In conclusion, this case supports the usefulness of monitoring using aEEG. This system may be helpful for intensivists to evaluate neurological conditions or prognosis of patients with suspected hypoxic ischemic encephalopathy in the early stage of the clinical course, allowing for the initiation of other surgical and medical interventions.

Conflict of interest

The authors declare no conflicts of interest.

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Ethical approval

We have nothing to declare.

Consent

We have nothing to declare.

Author contribution

We have nothing to declare.

Registration of research studies

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References

- [1] J. Soar, C.D. Deakin, J.P. Nolan, G. Abbas, A. Alfonzo, A.J. Handley, et al., European resuscitation council guidelines for resuscitation 2005. Section 7. Cardiac arrest in special circumstances, *Resuscitation* 67 (Suppl 1) (2005) S135–S170.
- [2] J.S. Gerdes, E.U. Walther, S. Jaganjac, M. Makrigeorgi-Butera, S.G. Meuth, M. Deppe, Early detection of widespread progressive brain injury after cardiac arrest: a single case DTI and post-mortem histology study, *PLoS One* 9 (2014) e92103.
- [3] F.J. Mateen, K.A. Josephs, M.R. Trenerry, M.D. Felmlee-Devine, A.L. Weaver, M. Carone, et al., Long-term cognitive outcomes following out-of-hospital cardiac arrest: a population-based study, *Neurology* 77 (2011) 1438–1445.
- [4] R.A. Agha, A.J. Fowler, A. Saeta, I. Barai, S. Rajmohan, D.P. Orgill, et al., The SCARE statement: consensus-based surgical case report guidelines, *Int. J. Surg.* 34 (2016) 180–186.
- [5] P. Safar, Cerebral resuscitation, *Mt. Sinai J. Med.* 48 (1981) 385–388.
- [6] D. Maynard, P.F. Prior, D.F. Scott, Device for continuous monitoring of cerebral activity in resuscitated patients, *Br. Med. J.* 4 (1969) 545–546.
- [7] P.F. Prior, D.E. Maynard, P.C. Sheaff, B.R. Simpson, L. Strunin, E.J. Weaver, et al., Monitoring cerebral function: clinical experience with new device for continuous recording of electrical activity of brain, *Br. Med. J.* 2 (1971) 736–738.
- [8] R.E. Spitzmuller, T. Phillips, J. Meinzen-Derr, S.B. Hoath, Amplitude-integrated EEG is useful in predicting neurodevelopmental outcome in full-term infants with hypoxic-ischemic encephalopathy: a meta-analysis, *J. Child Neurol.* 22 (2007) 1069–1078.
- [9] M. Rundgren, I. Rosén, H. Friberg, Amplitude-integrated EEG (aEEG) predicts outcome after cardiac arrest and induced hypothermia, *Intensive Care Med.* 32 (2006) 836–842.
- [10] S.H. Oh, K.N. Park, Y.M. Shon, Y.M. Kim, H.J. Kim, C.S. Yoon, et al., Continuous amplitude-integrated electroencephalographic monitoring is a useful prognostic tool for hypothermia-treated cardiac arrest patients, *Circulation* 132 (2015) 1094–1103.

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