J Anesth (2010) 24:447–451
DOI 10.1007/s00540-010-0911-8

CLINICAL REPORT

Cardiac arrest in the left lateral decubitus position and extracorporeal cardiopulmonary resuscitation during neurosurgery: a case report

Tetsuhiro Takei · Koichi Nakazawa · Seiji Ishikawa · Tokujiro Uchida · Koshi Makita

Received: 8 January 2010 / Accepted: 29 January 2010 / Published online: 20 March 2010

Abstract Cardiopulmonary resuscitation (CPR) in the lateral position during noncardiac surgery has been described in only a few reports in the past. Here, we report a case of cardiac arrest in a 61-year-old man undergoing microvascular decompression surgery for trigeminal neuralgia in the left lateral decubitus position. During the initial 5 min of CPR, chest compression was performed in this position by two rescuers; one from the chest and the other from the back, pushing simultaneously. Because ventricular arrhythmia was refractory to conventional CPR even after placing the patient back to the supine position, extracorporeal life support was introduced in the operating room by using the femoro–femoral approach (right atriofemoral veno-arterial bypass). This alternative CPR markedly decreased the frequency of ventricular arrhythmia. Subsequent coronary angiogram detected 99% stenosis of the right coronary artery. Ventricular arrhythmia ceased after coronary revascularization, and the patient was successfully weaned from the extracorporeal bypass circuit. The patient was discharged alive with minimal neurological impairment. We suggest that chest compression in the lateral position by two rescuers is an efficient resuscitation maneuver, and if an electrical storm is refractory to conventional CPR, extracorporeal life support should be considered in the operating-room setting.

T. Takei (✉)
Department of Intensive Care Medicine, Yokohama City Minato Red Cross Hospital, 3-12-1 Shin-yamashita, Naka-ku, Yokohama 231-8682, Japan
e-mail: takei.icu@yokohama.jrc.or.jp

K. Nakazawa · S. Ishikawa · T. Uchida · K. Makita
Department of Anesthesiology and Critical Care Medicine, School of Medicine, Tokyo Medical and Dental University, Tokyo, Japan

Keywords Cardiac arrest · Left lateral decubitus position · Extracorporeal life support · Cardiopulmonary resuscitation · Electrical storm

Introduction

Cardiac arrest caused by a coronary event during noncardiac surgery is challenging and the outcome of these patients is still unsatisfactory. Here, we report a case of sudden cardiac arrest during neurosurgery that was being performed with the patient placed in the left lateral decubitus position. Because the cardiac arrest was refractory to conventional cardiopulmonary resuscitation (CPR), extracorporeal life support was introduced in the operating room.

Case report

A 61-year-old man (167 cm, 66 kg) underwent elective microvascular decompression surgery for right trigeminal neuralgia. He had had hypertension for several years. He was a nonsmoker, and had never experienced syncope, chest pain, or congestive heart failure. Preoperative electrocardiogram (ECG) showed occasional supraventricular paroxysmal contraction and left ventricular hypertrophy.

On the morning of the surgery, he had taken his regular doses of carbamazepine and amlodipine. General anesthesia was induced with an intravenous infusion of propofol, fentanyl, and vecuronium. Anesthesia was maintained with sevoflurane (0.5%–1.5%) and nitrous oxide (60%) with oxygen. Mechanical ventilation was adjusted to keep end-tidal carbon dioxide tension around 30 mmHg. ECG was monitored in lead II, and an arterial catheter was inserted

from the left radial artery. The patient was placed in the left lateral decubitus position for the surgical procedure by covering the left side of his thorax with a negative-pressure fixation device. His head was immobilized by a 3-point skeletal fixation device. Blood gas analysis demonstrated no abnormal findings. Immediately after the skin incision, mannitol was infused. Arterial pressure was 112/63 mmHg, and the heart rate, 68 beats/min.

The dura was cut open 20 min after the skin incision. Simultaneously, systolic arterial pressure dropped to 70 mmHg. Bolus infusion of 5 mg of ephedrine hydrochloride was ineffective, and frequent paroxysmal ventricular contractions appeared, with marked elevation of the ST segment on lead II. Subsequently, nonsustained ventricular tachycardia (VT) appeared, and 50 mg of lidocaine was administered. Polymorphic VT was seen, and therefore 2 g of magnesium sulfate was infused. However, the patient developed ventricular fibrillation (VF) 35 min after the start of the operation. We removed the instrument table, which had been above the patient, began suturing the open dura immediately, and started a chest compression maneuver in the lateral decubitus position. Initially, chest compression was performed by one rescuer, by placing the patient's thorax in between two hands, compressing the chest by applying pressure from the front and the back. However, this maneuver seemed to be insufficient to obtain efficient cardiac output. Subsequent chest compression was performed by two rescuers; one rescuer's hands on the patient's sternum and the other one's hands on his back, pushing simultaneously. With this method, arterial blood pressure reached 70–80 mmHg. Though the patient's cardiac rhythm was still showing VF, we could not use the defibrillator because the body-fixation device covered his thorax and kept him in the left lateral decubitus position. Five minutes after initiating CPR, the dura was closed, and he was turned back into the supine position. We applied a 200-J monophasic shock, but this was ineffective. Bolus infusion of 1 mg of adrenaline was started, and given at 5 min intervals. Ten minutes after initiating CPR, a continuous infusion of lidocaine was initiated, and given at 60 mg/h. In order to correct hyperkalemia (6.0 mEq/L) and metabolic acidosis (HCO_3^- 14.9 mEq/L), 40 mL of 7% bicarbonate sodium was infused slowly. After 22 min of CPR, his circulation was restored. However, he soon went back into pulseless VT and VF. Various waveforms on the ECG monitor during the electrical storm are shown in Fig. 1. We could not eliminate the electrical storm by conventional CPR, which involved 4 shock deliveries. Hence, we decided to perfuse the patient with an extracorporeal cardiopulmonary bypass circuit. Thirty-five minutes after initiating CPR, veno-arterial extracorporeal circulation was instituted by cannulating the right atrium via the right femoral vein as the drainage access and the left femoral artery as the return access. After introducing the extracorporeal circulation, the frequency of the ventricular arrhythmia decreased markedly.

Electrocardiogram obtained in the intensive care unit showed marked ST-segment elevation in leads II, III, aV_F, and $V_{5–6}$ with reciprocal ST depression in leads $V_{1–3}$ (Fig. 2). An emergency percutaneous coronary intervention was performed and a stent was implanted in segment 3 of the right coronary artery, where 99% stenosis was detected (Fig. 3). After coronary revascularization, the ventricular arrhythmia ceased completely and the patient became hemodynamically stable. Unfractionated heparin was administered continuously to prevent thrombus formation in the stent and within the bypass circuit by maintaining activated coagulation time within 150–200 s. Four hours after the cardiac arrest, the patient regained consciousness, responded to verbal commands, and demonstrated no apparent limb paresis. Seven hours after the cardiac arrest, the patient was successfully weaned from the extracorporeal bypass circuit.

Approximately 20 h after the onset of the cardiac arrest, the patient showed depression in his level of consciousness. A computed tomography scan revealed right cerebellar hemorrhage and acute hydrocephalus, which required an emergency hematectomy. He made satisfactory neurological progress, and on the 33rd postoperative day, he was discharged home, with slight left hemiparesis and mild cerebellar ataxia remaining.

Three months after the operation, a follow-up coronary angiogram was performed. Intracoronary infusion of 50 μg of acetylcholine induced paradoxical vasospasm (99% stenosis) in the middle portion of the left anterior descending artery. ECG showed significant ST-segment depression in leads $V_{5–6}$, and the patient expressed a feeling of heaviness in the chest. These findings recovered after an intracoronary infusion of isosorbide dinitrate. The patient was diagnosed with vasospastic angina, and placed on diltiazem.

Discussion

Although there have been many reports of CPR performed on patients in the prone position [1], limited information is available for CPR performed on patients in the lateral position. Adachi et al. [2] reported a case of VF during neurosurgery in the right lateral position. However, there was no detailed description of chest compression performed in this position, and no requirement for defibrillation because normal sinus rhythm was restored spontaneously within several minutes. In another case report, CPR in the lateral decubitus position was administered to a 6-year-old boy during neurosurgery [3]. In this

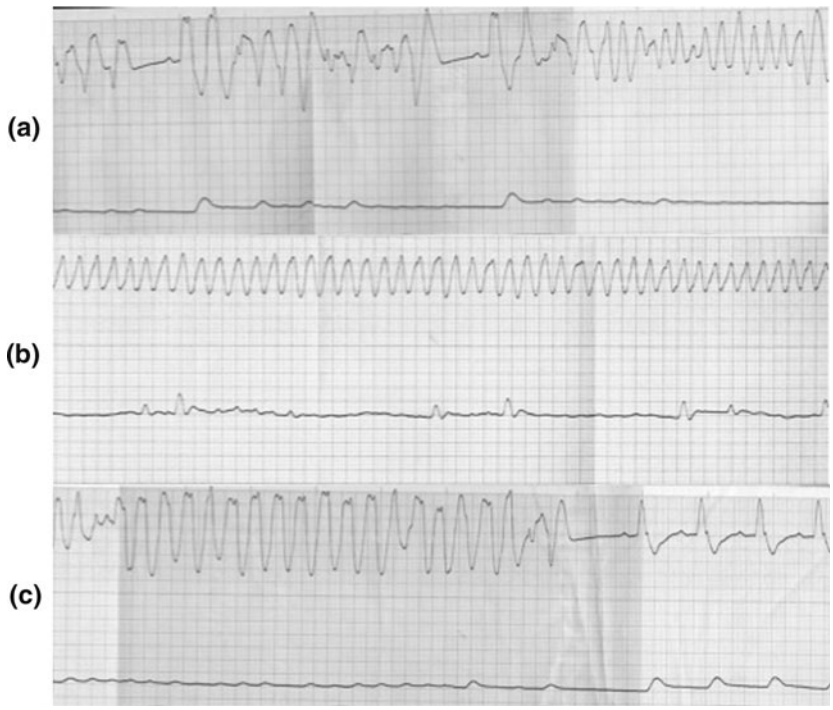

Fig. 1 Various electrocardiographic waveform recordings in lead II during cardiopulmonary resuscitation. *Lower trace* in each panel shows arterial pressure recordings. **a** Sinus rhythm with marked ST elevation turned into polymorphic ventricular tachycardia. **b** Despite various efforts, the patient developed ventricular fibrillation 35 min after the start of the operation. **c** Sinus rhythm was temporarily restored during the electrical storm

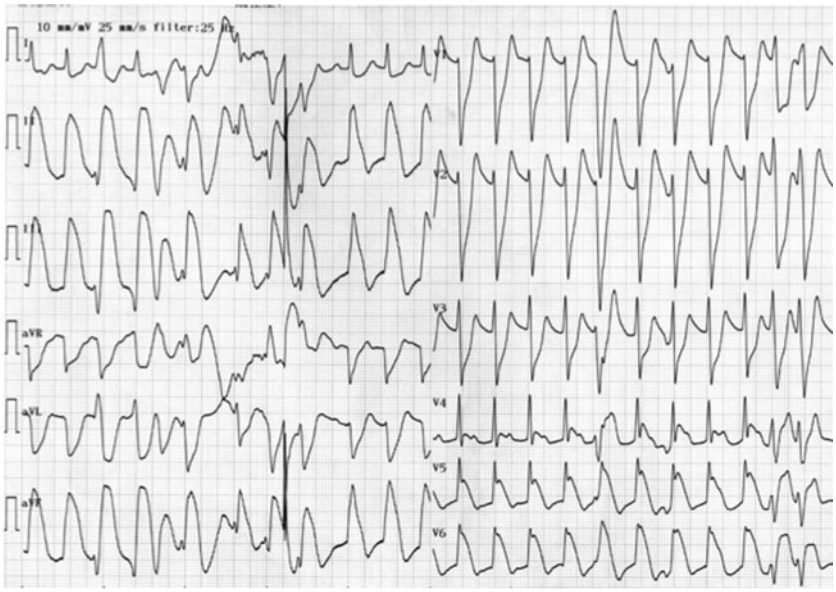

Fig. 2 Electrocardiogram recorded in the intensive care unit. Marked elevation of the ST segment in leads II, III, aV_F, and $V_{5–6}$ was accompanied by a reciprocal ST depression in leads $V_{1–3}$

case, chest compression was performed by one rescuer because of the patient's small body size, and he too did not require defibrillation. However, in our patient, chest compression had to be applied in the lateral position by two rescuers during the initial 5 min of CPR. Because no motor palsy was found before brain hematectomy, we concluded that the left hemiparesis and mild cerebellar ataxia at discharge were a consequence of cerebellar hemorrhage, and not of global brain ischemia related to cardiac arrest and CPR. Therefore, this case indicates that synchronous chest compression performed by two rescuers on a patient in the lateral position provides sufficient cardiac output during CPR.

To our knowledge, this is the first report that describes extracorporeal CPR introduced in the operating room to overcome unexpected cardiac arrest during noncardiac surgery. The feasibility of extracorporeal CPR for in-hospital cardiac arrest has been reported [4–7]. Especially, refractory ventricular arrhythmia has been demonstrated to be a good indicator for starting this alternative CPR method

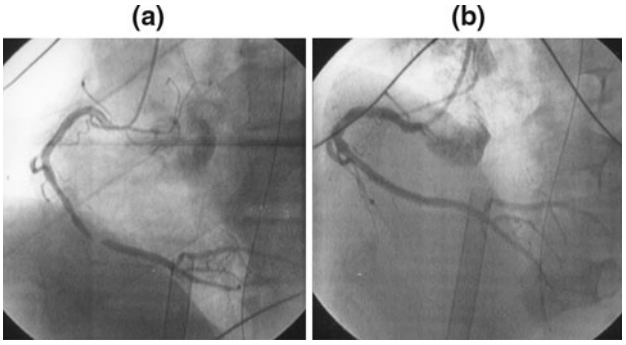

Fig. 3 Coronary angiogram of the right coronary artery under extracorporeal circulation. **a** 99% stenosis was found in the middle portion of this artery. **b** After percutaneous coronary intervention, no stenosis was found. Hemodynamic instability was completely eliminated after coronary revascularization

[6, 7]. In addition, during general anesthesia, patients are not only monitored and are mechanically ventilated, but there is also easy access to the arterial and central venous lines. Therefore, extracorporeal CPR during surgery is a treatment of choice when cardiac arrest is refractory to conventional CPR.

Previous reports have shown that the longer the duration of CPR before the induction of extracorporeal circulation, the lower the survival rate [4]. We were able to establish the bypass circulation 35 min after initiating CPR. As with previous cases [7], ventricular arrhythmia decreased markedly after establishing the bypass circulation. Thus, we believe that in patients suffering from an electrical storm during surgery, introducing extracorporeal life support in the early phase of CPR works as a bridging therapy to maintain sufficient cerebral and coronary circulation until successful coronary intervention can be completed.

Intraoperative cardiac arrest due to coronary events is rare in the Japanese population compared with the Western population. According to a 3-year survey by the Japanese Society of Anesthesiologists, the rate of occurrence of intraoperative cardiac arrest due to coronary ischemia was 0.0087% [8]. On the other hand, there have been many case reports of coronary spasms occurring during surgery in the Japanese population [9]. Elderly men with one or more coronary risk factors and no prior history of coronary ischemia are likely to experience coronary spasms. In the present case, the patient had a history of hypertension with no history of coronary ischemia, and his acetylcholine spasm-provocative test was positive. In addition, alkalemia, dehydration, hypotension, and the administration of ephedrine are all known to induce coronary spasms [9, 10]. Therefore, a combination of these predisposing factors may have induced the coronary spasms in our patient, thereby leading to the development of an electrical storm and hemodynamic instability.

Because our patient was maintained in the left lateral decubitus position with a fixation device, we could not apply the first shock for more than 5 min after his cardiac arrest. For cardioversion of atrial fibrillation, the alternative anterior–posterior electrode position has been reported to be as effective as the standard anterior–lateral electrode position [11, 12]. However, information regarding the anterior–posterior electrode position for defibrillation of VF is limited. Using this anterior–posterior shock method in the left lateral position could have been an alternative in our patient, because the delay in application of the first shock may have been one of the reasons the patient developed CPR-resistant cardiac arrest.

In summary, a patient undergoing neurosurgery in the left lateral position manifested sudden cardiac arrest due to acute coronary syndrome, and CPR was administered in this position for 5 min. Although ventricular arrhythmia was refractory to conventional CPR, extracorporeal CPR worked as an efficient bridging therapy until coronary intervention therapy could be completed. We conclude that the chest compression maneuver in the lateral position, performed by two rescuers, and extracorporeal CPR for refractory cardiac arrest during noncardiac surgery are effective resuscitation tools.

References

1. Brown J, Rogers J, Soar J. Cardiac arrest during surgery and ventilation in the prone position: a case report and systematic review. Resuscitation. 2001;50:233–8.
2. Adachi N, Miyamoto Y, Hodono S, Yorozuya T, Arai T. Management of unexpected coronary artery spasm in an asymptomatic patient during anaesthesia. Acta Anaesthesiol Scand. 2003;47:1172–3.
3. Abraham M, Wadhawan M, Gupta V, Singh AK. Cardiopulmonary resuscitation in the lateral position: is it feasible during pediatric intracranial surgery? Anesthesiology. 2009;110:1185–6.
4. Chen YS, Lin JW, Yu HY, Ko WJ, Jerng JS, Chang WT, Chen WJ, Huang SC, Chi NH, Wang CH, Chen LC, Tsai PR, Wang SS, Hwang JJ, Lin FY. Cardiopulmonary resuscitation with assisted extracorporeal life-support versus conventional cardiopulmonary resuscitation in adults with in-hospital cardiac arrest: an observational study and propensity analysis. Lancet. 2008;372:554–61.
5. Mégarbane B, Leprince P, Deye N, Résière D, Guerrier G, Rettab S, Théodore J, Karyo S, Gandjbakhch I, Baud FJ. Emergency feasibility in medical intensive care unit of extracorporeal life support for refractory cardiac arrest. Intensive Care Med. 2007;33:758–64.
6. Chen JS, Ko WJ, Yu HY, Lai LP, Huang SC, Chi NH, Tsai CH, Wang SS, Lin FY, Chen YS. Analysis of the outcome for patients experiencing myocardial infarction and cardiopulmonary resuscitation refractory to conventional therapies necessitating extracorporeal life support rescue. Crit Care Med. 2006;34:950–7.
7. Tsai FC, Wang YC, Huang YK, Tseng CN, Wu MY, Chang YS, Chu JJ, Lin PJ. Extracorporeal life support to terminate refractory ventricular tachycardia. Crit Care Med. 2007;35:1673–6.

8. Irita K, Kawashima Y, Morita K, Tsuzaki K, Seo N, Iwao Y, Obara H. Life-threatening coronary ischemia in the operating room: Analysis of annual survey from 1999 to 2001 conducted by Japanese Society of Anesthesiologists (in Japanese with English abstract). Masui. 2003;52:304–19.
9. Koshiba K, Hoka S. Clinical characteristics of perioperative coronary spasm: reviews of 115 case reports in Japan. J Anesth. 2001;15:93–9.
10. Kawano H, Ogawa H. Endothelial function and coronary spastic angina. Intern Med. 2005;44:91–9.
11. Kerber RE, Jensen SR, Grayzel J, Kennedy J, Hoyt R. Elective cardioversion: influence of paddle-electrode location and size on success rates and energy requirements. N Engl J Med. 1981;305:658–62.
12. Kirchhof P, Eckardt L, Loh P, Weber K, Fischer RJ, Seidl KH, Böcker D, Breithardt G, Haverkamp W, Borggrefe M. Anterior–posterior versus anterior–lateral electrode positions for external cardioversion of atrial fibrillation: a randomised trial. Lancet. 2002;360:1275–9.