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Profound Hypothermic Cardiac Arrest Treated Successfully Using Minimally Invasive Cardiopulmonary Bypass: A Case Report

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ABSTRACT

Background. Hypothermia is defined as a core temperature of less than 35°C. The decision to resuscitate a hypothermic patient can be difficult. as consideration must be given to whether the patient died before the cooling process. The modality for rewarming must also be considered.

Case Report. A severely hypothermic 54-year-old man with a core temperature of 21°C was successfully rewarmed using cardiopulmonary bypass via the femoro-femoral route. The patient made a full neurological recovery.

Conclusion. Cardiopulmonary bypass provides excellent circulatory support for profound hypothermia and allows rapid core rewarming. The femoro-femoral approach is the preferred method for this scenario.

INTRODUCTION

Hypothermia is defined as a core body temperature below 35°C. It is classified as moderate (32-35°C), severe (28-32°C), and profound (<28°C). Severe hypothermia has a mortality rate of 80% [Mills 1973]. The decision to resuscitate a deeply hypothermic patient is a difficult one, because consideration must be given to the cause of the condition. Essentially, the clinician must consider whether the patient is hypothermic following death or is asystolic following hypothermia. We present an unusual case of deep hypothermic arrest treated successfully with cardiopulmonary bypass and review the literature.

CASE REPORT

A 54-year-old Caucasian man was found in a public house car park at 0800 hours in mid-December with an ambient temperature of –3°C. He was cold and unresponsive with a Glasgow Coma Scale of 3. His clothes were wet and frosty. There was no evidence of trauma but an empty bottle of diazepam was found nearby. There was no available history as no witnesses were present. On examination by paramedic staff, his tympanic temperature was noted at 21°C while electrocardiography confirmed asystole. The patient was intubated, ventilated, and external cardiac massage was initiated. Despite the administration of 6 boluses of 1 mg intravenous epinephrine and 3 mg atropine he remained in asystole. On arrival at hospital, the patient was identified from records as having a history of medication misuse (diazepam, captopril) and obsessive neurosis. On examination, his pupils were fixed and dilated. Arterial blood gas analysis demonstrated severe metabolic disorders with marked lactic acidosis. His pH was 7.12, pO2 11.2 kPa, pCO2 4.6 kPa, and base deficit –16. External massage was continued and the patient was actively warmed using a forced-air warming blanket (BairHugger, Arizant Healthcare, Minneapolis, MN, USA). The cardiothoracic team was contacted and the patient was taken to the operating theater for rapid rewarming on cardiopulmonary bypass.

Vascular access was achieved prior to surgery via the right internal jugular vein through which a Swan-Ganz monitoring line was also inserted. Following heparinization (3 mg/kg), the right femoral vein was cannulated percutaneously using a 20-French venous cannula (Edwards Lifesciences, Irvine, CA, USA). The left femoral artery was surgically exposed and cannulated with a 22-French aortic cannula (DLP, Minneapolis, MN, USA). Cardiopulmonary bypass was established with flow rates between 3.3 to 3.6 L/min and mean perfusion pressures of 55 to 60 mmHg. The blood temperature on initiating bypass was noted to be 20°C. Active rewarming was undertaken at 4°C every 15 minutes. At 26°C the patient was noted to be making respiratory efforts. He was then paralyzed with vecuronium, a nondepolarizing neuromuscular blocker (Organon, West Orange, NJ, USA) and commenced on a propofol (AstraZeneca, Wilmington, DE, USA) infusion at 5 mL/kg per hour. When the nasopharyngeal temperature reached 30°C, coarse ventricular fibrillation was noted. This required 6 attempts at cardioversion with 360 joules before successfully reverting to sinus rhythm. This was maintained with intravenous infusion of amiodarone initially at 300 mg over 30 minutes followed by 900 mg over 24 hours. Eight mmoL

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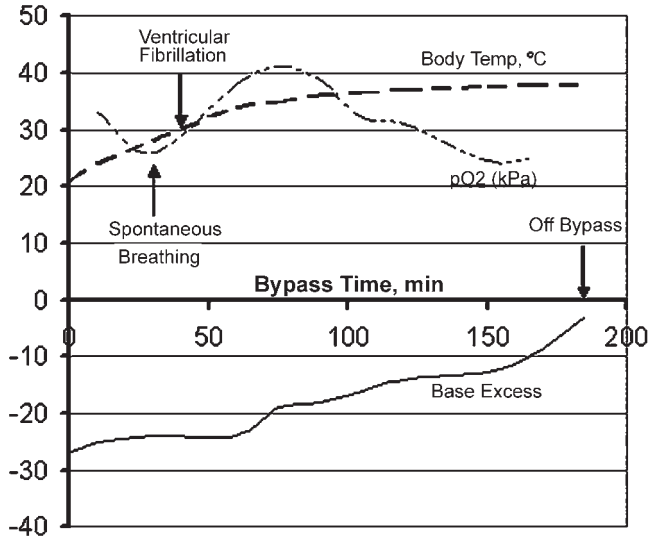
of magnesium were also administered. The sequence of events during rewarming on bypass is shown in the Figure.

After 185 minutes on bypass, the patient was fully rewarmed with a nasopharyngeal temperature of 37°C. The heart was in sinus rhythm and ejecting well, supported only with a low dose of epinephrine (0.3 mcg/kg per min) and norepinephrine (0.1 mcg/kg per min). The metabolic acidosis was corrected with a total of 250 mg of bicarbonate. The patient was successfully weaned off bypass and transferred to the intensive care unit. Hemodynamics on termination of bypass showed a cardiac output of 6.5 L/min with a cardiac index of 3.2. The patient's subsequent recovery was uncomplicated and he was discharged for rehabilitation to the physicians on the fifth postoperative day without any neurological deficit as confirmed clinically and by a cranial computed tomography scan.

DISCUSSION

Hypothermia represents a unique scenario in which survival after prolonged cardiac arrest is possible with no serious long-term sequelae. The prognosis of the patient with circulatory arrest due to deep hypothermia depends on various factors, such as underlying disease, extremes of age, duration prior to treatment, and most importantly, methods of management including external or internal rewarming [Knobel 2001]. During circulatory arrest, the patient usually requires invasive methods of rewarming. Extracorporeal rewarming is the method of choice because of its ability to maintain and alter temperature while providing efficient circulatory support [Mateer 1985; Wollenek 2002]. Good results have also been reported with other forms of invasive methods such as veno-venous hemofiltration, hemodialysis, and peritoneal dialysis [Hernendez 1993; Vella 1996; Spooner 2000]. Although there are a number of methods of external rewarming, for example forced air blankets and hot baths, these methods have no practical application in the treatment of a patient in severe or profound hypothermia.



Sequence of events during minimally invasive rewarming.

The choice of vascular access for cannulation for cardiopulmonary bypass is important. We selected the femoro-femoral route to avoid postoperative complications associated with sternotomy such as bleeding secondary to hypothermic coagulopathy, pain control, and wound infection. Most reports in the medical literature perform a sternotomy for bypass [Walpoth 1997].

Most successful cases of successful resuscitation from severe or profound hypothermia treated by cardiopulmonary bypass are young and otherwise healthy subjects following mountain accidents or cold-water immersion. Our case represents a 54-year-old man suffering from a behavioral disorder who presumably overdosed on benzodiazepines. This "urban" hypothermia usually affects fragile subjects, such as the elderly, alcoholics, and drug addicts, and the body temperature is rarely below 25°C [Vassal 2001].

Predisposing causes of hypothermia include cerebrovascular disease, mental retardation, pituitary and adrenal insufficiency, acute alcoholism, hypothalamic dysfunction, sepsis, diabetic ketoacidosis, polypharmacy, and, especially, the use of sedative and narcotic drugs [Knobel 2001]. Our patient belonged to a risk group of people highly predisposed to accidental deep hypothermia because of age and history of frequent medication overdose. However, he was also previously diagnosed with syndrome of inappropriate antidiuretic hormone due to clomipramine overdose. We were faced with a patient with no signs of life. We had no information on how long he was exposed to very low external temperature and whether he was under the influence of alcohol that would have increased the hypothermic process. Moreover, he could have died from a massive intracranial catastrophe. The decision to proceed to rewarm him was based on the adage "not dead until warm and dead." Furthermore, on arrival his blood gas sample showed good gas exchange. It was this factor that prevailed and aided our decision to proceed to extracorporeal resuscitation.

Ko et al report that all patients in deep hypothermia with any evidence of cardiac activity should proceed to resource intensive rewarming with cardiopulmonary bypass [Ko 2002]. Our case shows that a patient with persistent asystole still may successfully recover from cardiac arrest in deep hypothermia.

In conclusion, we present a unique case of successful resuscitation of a deeply hypothermic 54-year-old man found after a presumed drug overdose. The case strongly advocates the use of cardiopulmonary bypass in the treatment of cardiac arrest in accidental deep hypothermia. Rapid institution of full cardiopulmonary bypass provides excellent circulatory support and rapid rewarming. Moreover, the femoro-femoral approach to establish cardiopulmonary bypass is a preferred method in this scenario.

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