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Case Report

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Hypothermic Trauma Patients-Rewarming Before Trauma Assessment?

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Abstract

Background: The treatment of hypothermic patients suffering from severe trauma is challenging, mainly because of coagulation disorder and potential hemodynamic instability either caused by hemorrhage or accidental hypothermia.

Case presentation: We report a single case of an otherwise healthy man who sustained multiple injuries combined with severe accidental hypothermia (< 26°C) in the French Alps. Rewarming was initiated very early in the trauma assessment and before surgical interventions. Despite the very low core temperature, the patient was hemodynamically stable and therefore did not qualify for extracorporeal life support ECLS. In-hospital rewarming consisted of minimally invasive, active external rewarming. Surgical interventions were postponed because of a coagulopathy, caused by severe accidental hypothermia.

Conclusions: In selected cases, correction of hypothermia and associated coagulation disorders before surgical interventions might improve the chances for survival in hypothermic trauma patients. Thromboelastography (TEG) in the emergency department might be useful to assess hypothermia-associated coagulopathies.

Keywords: Accidental hypothermia; ECLS; Multiple Coagulation trauma; Rewarming; Thromboelastography

Introduction

Introduction: Still today, the combination of severe trauma with hypothermia, acidosis and coagulation disorder, known as lethal triad of trauma [1], has a higher mortality than the trauma itself [2]. Several case reports showed improved survival with a concept of rewarming before full trauma assessment [3,4]. The use of extracorporeal life support (ECLS) for severely hypothermic patients who are either hemodynamically unstable or even in cardiac arrest has become the gold standard for treating these patients [5, 6]. We present the case of an otherwise healthy mountaineer who sustained severe injuries caused by an ice avalanche. Rewarming started very early during resuscitation and was continued in the emergency department. Surgical interventions were delayed due to the existing coagulation disorder. The patient gave his written consent for the publication and contributed to the final document.

Case report: In August 2013, at 2.30 a.m., a mountain guide and two experienced female mountaineers left the Refuge des Cosmiques (3613 m) in the region of Chamonix, France, in order to climb Mont Blanc (4810 m). At 3.30 a 'serac', i.e. an avalanche of

snow and blocks of ice, fell down from Mont Blanc du Tacul on 4100 m and hit the three alpinists. The mountain rescue service PGHM (Peloton Gendarmerie de Haute Montagne) with an emergency physician started at dawn and arrived on scene at 7.30. The two women were completely buried in a crevasse and were declared dead on site. The mountain guide was lying partially buried on the glacier's surface. He was unconscious but showed vital signs: the primary survey revealed a patent airway, spontaneous breathing with a respiratory rate of 10/min and decreased breath sounds on the left. Heart rate was 92/min, blood pressure 90/60 mmHg, Glasgow Coma Scale (GCS) 9 (E2V3M4) and epitympanic core temperature 25.2°C. There were no visible signs of hemorrhage. The rescue team administered oxygen and iv cristalloids. The patient was insulated with bubble wraps and aluminium foils and fully immobilized on a spine board with a C-collar.

At 9:15, the helicopter flew the patient to the hospital in Annecy, capable of Extracorporeal Life Support (ECLS). On admission, the patient showed subcutaneous emphysema and an oxygen saturation of 84%, but was haemodynamically stable. The pelvis appeared stable and there was no evidence of external bleeding. The Extended Focused Assessment with Sonography for Trauma (EFAST) showed a small amount of free fluid in the hepatorenal recess and no left pleural sliding. GCS was 6 (E1V1M4), pupils were symmetric and reactive. Rectal core temperature was 25.9°C. The right knee was dislocated with preserved peripheral circulation. The patient was sedated (etomidate 20mg+suxamethonium 80mg), intubated and ventilated. Volume replacement was continued. Minimally invasive, active external rewarming was performed using hot blankets on the trunk, warm iv-fluids and forced air.

At 10 a.m., radiological exams were performed. The full-body CT-scan revealed a small intracerebral hemorrhage in the right cortical frontal lobe, bilateral pneumothorax (maximum size 3 cm), bilateral pulmonary contusion, but no abdominal bleeding. The knee X-ray confirmed a posterior dislocation without fracture. The dislocation was reduced and external rewarming continued. During rewarming, the blood pressure dropped to 72/54 mmHg without evidence of hemorrhage or cardiac arrhythmias. Vasopressors were started and volume therapy intensified. The laboratory results are shown in **Table 1**.

Time	09:00	10:00	14:00	15:00	16:00	19:00	21:00	08:00
pH	7.13	-	7.12	-	7.23	7.29	7.32	-
PaO_2 (mmHg)	72.9	-	85.9	-	103	84	94.2	-
$PaCO_2$ (mmHg)	39.8	-	46.2	-	30.9	28	24.6	-
Bicarbonate (mmHg)	12.7	13.7	14.4	-		13	12.3	-
FiO_2	-	-	0.9	-	0.9	0.5	0.5	-
Hemoglobin (g/dL)	15	-	-	-	-	13.9	-	-
Platelets (x1000/µL)	246	-	-	-	-	211	-	-
Fibrinogen (mg/dL)	-	-	-	-	-	190	-	-
PT ratio (%)	52	-	-	-	-	64	69	-
PTT (sec)	-	-	-	-	-	33	-	-
Calcium ion (mmol/L)	-	-	-	-	1.02	-	-	-
Lactate (mmol/L)	6.2	-	4.4	-	5.3	-	-	-
Sodium (mmol/L)	-	-	138	-	138	140	-	
Potassium (mmol/L)	-	-	2.9	-	3.3	3.6	-	6.2
Creatinine (µmol/L)	-	-	108	-	-	97	-	132
Urea (mmol/L)	-	-	7.7	-	-	7.6	-	8.8
Glycemia (mmol/L)	17.3	14.5	-	-	7.8	5.9	-	-

Table 1: Lab results.

After 12 hours, the patient reached a core temperature of 37°C. On day 2, vasopressors and sedation were stopped. The patient spontaneously moved all extremities but was not fully responsive. On day 3, he was extubated. He was disoriented without focal neurological deficits. After being transferred to Aosta Hospital in Italy, his neurological status continuously improved. An MRI showed multiple small residual hemorrhages and signs of diffuse axonal injury. After 23 days, the patient was admitted to a rehabilitation unit and after 20 months resumed normal life.

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Discussion

We present the case of a patient suffering from severe hypothermia and multiple trauma caused by an ice avalanche. The air rescue arrived around four hours after the accident and had to declare the two companions dead. Our patient suffered from multiple trauma and severe accidental hypothermia with a core temperature below 26°C. Rewarming started in the prehospital setting and was continued in the emergency department. Our patient´s circulation was stable in the first assessment, despite a very low core temperature of 25.9°C. Therefore, he did not classify for active invasive rewarming. A primary survey, supplemented by an EFAST, and life-saving interventions as indicated were performed parallel to rewarming. The hypotensive period during rewarming without evidence of hemorrhage was probably due to hypovolemia, caused by cold diuresis, and the vasodilation, caused by the rewarming [7]. It was easily managed by low doses of norepinephrine and volume replacement. Severely hypothermic patients oftentimes require extensive volume replacement during rewarming. This should not distract the medical team from reassessing trauma patients for possible blood loss or other reasons for circulatory instability like cardiac tamponade, tension pneumothorax or neurogenic shock. We are not sure why the colleagues did not insert chest tubes, although the patient suffered from severe chest trauma with subcutaneous emphysema, bilateral pneumothorax and pulmonary contusion. He was intubated and ventilated, which additionally is an indication for chest tube insertion. We imagine that the team refrained from surgical interventions because they anticipated major bleeding caused by the coagulation disorder. In the first blood sample, platelets were normal, but prothrombin time ratio was reduced to almost half **(Table 1)**. Hypothermia usually leads to a sequestration of platelets in the liver with thrombocytopenia and platelet alteration, and inhibits thrombin generation and fibrinogen synthesis. This may increase the bleeding incidence and transfusion requirement in trauma patients [8]. Traditional coagulation analyses are performed at 37°C, and therefore do not well assess the extent of hypothermia-induced coagulopathy. Thromboelastography, a point-of-care test of the efficiency of blood coagulation, could add information about possible coagulation disorders already during the primary survey in the emergency department. Much to our surprise, our patient did not show major hemorrhage despite his severe trauma.

The assessment of hypothermic trauma patients can be challenging, as the clinical signs and symptoms can be misleading: In our case, the patient showed an initial GCS of 9 and later 6. This could be an expression of his traumatic brain injury (TBI) or due to hypothermia. Our patient had a TBI, which was confirmed in the CT scan, and showed neuropsychological deficits after extubation. This could either be caused by the TBI or hypothermia combined with possible hypoxia due to the chest trauma.

The initial core temperature, measured with an epitympanic probe, was 25.2°C. The esophageal probe that could be inserted after intubation, showed a core temperature of 25.9°C. The insulation performed on-site seems to be effective for avoiding further cooling. In our case, the clinical team decided to rewarm the patient with external methods like hot blankets, warm forced air and warmed infusions. This was reasonable as the patient was hemodynamically stable during the assessment and because of the risk of bleeding caused by trauma itself, and also by the use of extracorporeal circulation. If he had been under cardiac arrest or had suffered from hemodynamical instability, ECLS using Extracorporeal Membrane Oxygenation (ECMO) or Cardiopulmonary Bypass (CPB) would have been indicated. Although ECLS was not necessary, the decision of the rescue team to bring this patient to a center capable of ECLS was correct, as severe hypothermia is associated with the risk of a cardiac arrest [6].

Conclusion

The on-site treatment of hypothermic trauma patients and the care of these patients in the emergency department is challenging: The combination of hypothermia, acidosis and coagulopathy are still determinants for substantial morbidity and mortality in trauma patients. ECLS rewarming should be considered if the patient is hemodynamically unstable or in cardiac arrest. Coagulopathy must be assessed and corrected as soon as possible. Point-of-care thromboelastography in the ED should be considered. A dedicated team of trauma and hypothermia experts can contribute to a better survival and outcome in these low-incidence, but high-impact situations.

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