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CASE REPORT

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Profound cerebral cooling in an OHCA patient leads to an excellent neurological outcome after >10 h of ventricular fibrillation on eCPR

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Abstract

We here report a 40-year-old patient suffering from OHCA due to toxic drug abuse. Despite an unknown length of no- or slow-flow time on persisting ventricular fibrillation, the argument for the implantation of an ECLS was his juvenile age, lack of co-morbidities and severe hypothermia (26°C). In the following days, despite of a cerebral oedema this patient achieved a complete neurological regeneration without any clinical deficiencies and was discharged 17 days after admission.

Even though the routine use of extracorporal life support systems (ECLS) i.e. va-ECMO as part of an eCPR in Out-of-Hospital Cardiac Arrest (OHCA) patients is not yet recommended by the current guidelines, some tertiary care centrers provide good evidence for eCPR therapy in these OHCA patients. The lack of randomized controlled trials confuses this scenario in general but locoregional clinical algorithms and hospital cooperation such as cardiac arrest center networks will help to stratify and guide these patients to the right place at the right time and thereby improve clinical outcome for these patients with normally poor prognosis. This latter is true for those patients selected by clinical parameters such as an initially shockable rhythm, low no-flow time and a successful bystander CPR which favour for an early initiation of an eCPR therapy. Moreover, young age (<65years), pH >7.0 and serum lactat <2 mmol/l support us in our decision making to initiate eCPR treatment in an otherwise complete insecure situation.

Key words: *out of Hospital Cardiac Arrest (OHCA), eCPR, Hypothermia, Targeted temperature management (TTM)*

Introduction

In Europe, at least 275,000 patients per year suffer from extra-hospital cardiac arrests (OHCA). Since OHCA followed by cardiopulmonary resuscitation is initiated out of the hospital, an acceptable neurological outcome can often not be achieved [1-3]. The use of an extracorporal cardiopulmonary assist device (eCPR) often is the last therapeutic option for selected patients. As a results of several trials, ECLS is associated with a significantly higher survival rate [4-6]. However, there is currently no recommendation from the AHA or the European Council of Resuscitation regarding the routine use of an eCPR [2]. Causal is the lack of sufficiently randomized controlled trials with regard to these specific patients and the indication for eCPR. There are currently no clearly defined parameters that lead to a decision for or against an eCPR. So far, an observed cardiac arrest, the shortest possible no/low-flow duration (<60 min) as well as a low lactate level (<2 mmol/l) and a shockable heart rhythm have been turned out as good prognostic parameters. Also, the pH level and the presence of a reversible cause, such as a coronary heart disease, are associated with an increased survival [7]. Which parameters or their combination should ultimately be consulted and how in particular the limiting neurological outcome can be improved must be evaluated in further studies.

We would like to present the case of a 40-year-old man with extra-hospital cardiovascular arrest, therapy-refractory ventricular fibrillation an unclear no-flow time but with pronounced hypothermia (26 °C). After a certainly critical decision on eCPR and implantation of a vaECMO, the patient was discharged after full recovery without any remaining neurological deficits.

Case report

The 40-year-old male patient we want to report about suffered a cardiac arrest in October 2019 and was admitted to the Cardiac Arrest Centre of the University Hospital of Marburg. Previously, in the morning he had been found unconscious in his apartment with a body temperature of 26 °C. A cardiopulmonary resuscitation was immediately initiated by the emergency services. The initial heart rhythm was ventricular fibrillation, which could not be terminated by defibrillation or anti-arrhythmic therapy. The no-flow time proved to be unclear. The patient was last seen in the late evening of the previous day. Arterial blood gas analyses showed a hyperkalaemia (10 mmol/l) and a pH at 6.6. As pre diagnosis, a single cerebral seizure, a post-traumatic stress disorder and ADHD were known to the patient. The patient's family reported himself taking medications like benzodiazepines, amphetamines and weak opiates in the presence of previous described medical conditions. After arrival in the shock room, the arterial blood gas analysis showed a pH of 6.8, a lactate of 10 mmol/L and an arterial pO2 of 41.7 mmHg. Under ongoing cardiopulmonary resuscitation the immediate transport to our cathlab for vaECMO-

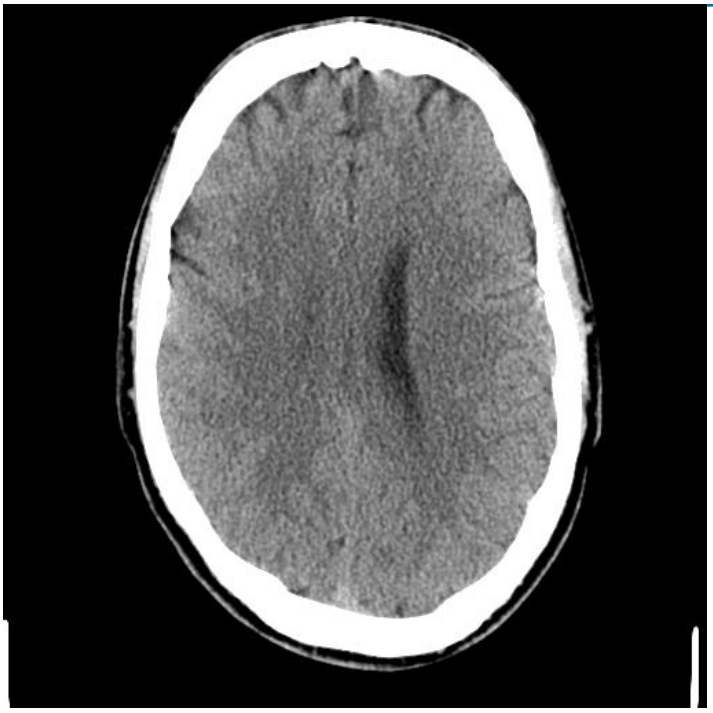

Figure 1. *Cerebral oedema (CT scan)*

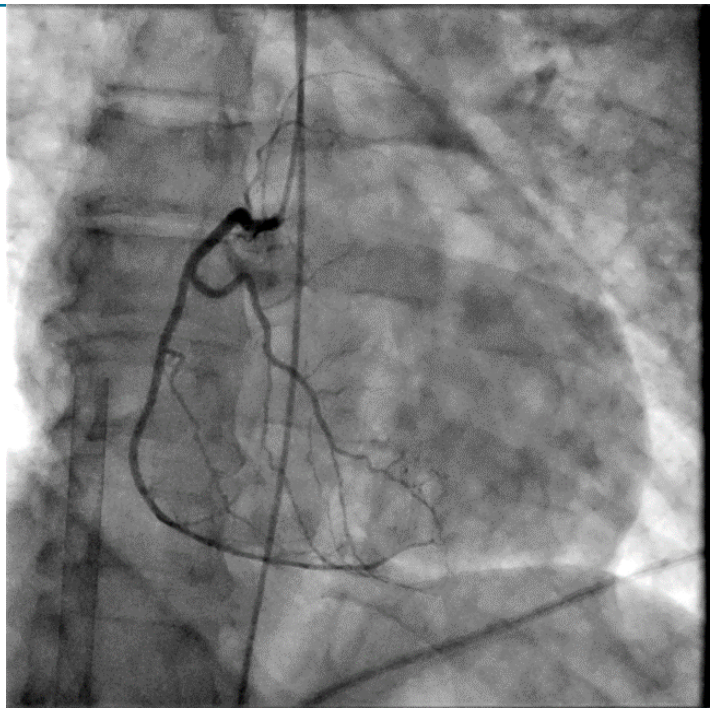

Figure 3. *Right coronary artery*

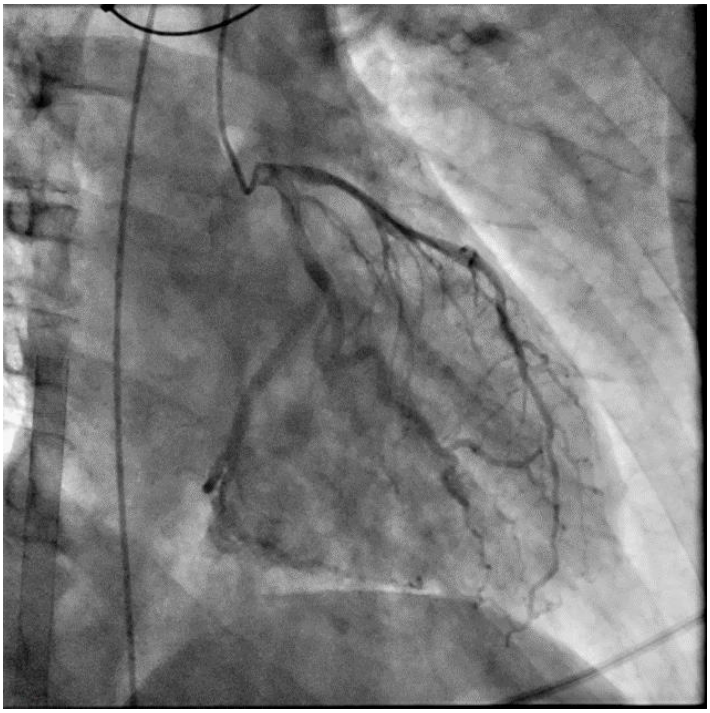

Figure 2. *Left coronary artery*

Figure 4. *No evidence of pulmonary embolism*

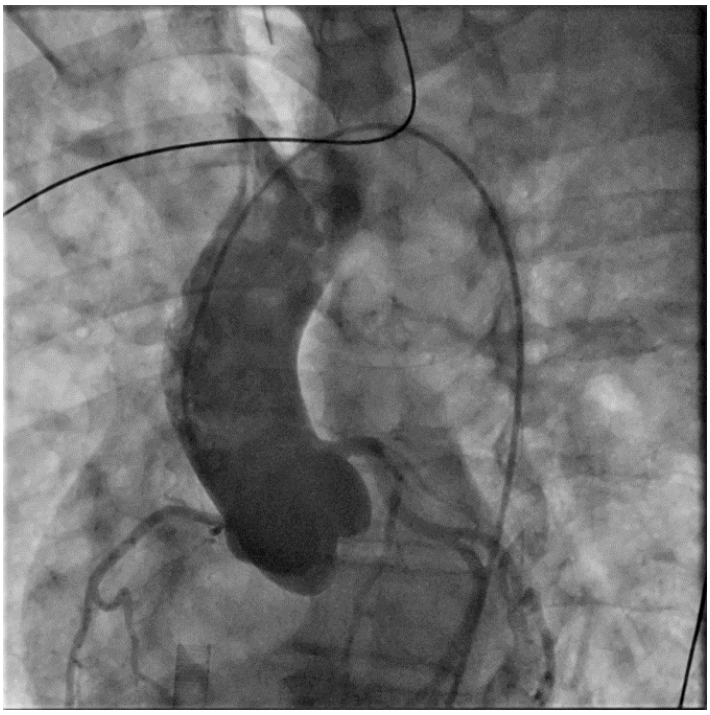

Figure 5. *No evidence of aortic dissection*

and coolguard® implantation (targeted temperature management) followed. A MAP of >60 mmHg to ensure organ and cerebral perfusion was kept by mechanical compression while the spontaneous cardiac cycle and myocardial contractility was still missing. The temperature remained at 26°C. After vaECMO implantation, a routinely performed coronary angiogram excluded any cause of cardiac ischemia. Moreover, multiple defibrillations remained still unsuccessful. Unfortunaltely, a whole-body CT scan carried out after ECLS implantation revealed the suspicion of a beginning hypoxic brain edema, as well as a pneumonia due to aspiration during the resuscitation but no further pathologies were detectable. The patient was transferred to the cardiac intensive care unit without ROSC but laminar blood flow from vaECMO maintained organ perfusion. The persisting ventricular fibrillation, which now lasted for at least 5 hours, could not be terminated even in this situation despite of meanwhile given multiple doses of antiarrhythmic drugs (xylocaine, amiodarone, magnesium) and multiple defibrillations. After more than 10 hours under laminar ECMO flow with a mean arterial pressure (MAD) of 58 up to 63 mmHg the successful conversion into the sinus rhythm was finally achieved by electrical defibrillation while the medication was saturated. Using the coolguard® catheter, the controlled warm-up phase (0.25°C/h) was first achieved up to 34°C. 24 hours after reaching this temperature we started the warming phase up to 37°C while adjusting the volume and catecholamine therapy. The pneumonia was treated antimicrobiologically (piperacillin/tazobactam, levofloxacin). In the case of acute kidney failure which initially occurs, most likely due to cardiogenic shock with conscutive reduced organ perfusion as well as rhabdomyolysis, there was an initial need for renal replacement therapy. Additionaly, after admission to the intensive care unit, the patient showed some phases of generalised myoclonus, which were treated with levetiracetam and valporid acid, both with regard to the history, the clinical aspect and suspected cerebral edema described in the CT can. After reaching the target body temperature of 37°C, no more myoclonus occurred. So we switched to levetiracetam monotherapy. After sufficient hemodynamic stabilization, the reduction and ultimately discontinuation of catecholamines, as well as the weaning and explanting of the vaECMO take part on day 8. Also, the weaning of the invasive ventilation and extubation on day 10 could be carried out. After a reduction of sedation, the patient appeared to be vigilant (RASS 0) within a few days and surprisingly mental fully oriented to all qualities, so that even after at least 10 hours without spontaneous circulation as well as imaging-related suspected cerebral edema due to cerebral hypoxia, however, under the hypothermia of 26 °C no relevant neurogenic as well as cerebral deficit has arisen. In the course of renal replacement therapy (CVVHD), the diuresis and detoxification function remained, all retention parameters decreased. So we could withdraw from the need of a permanent renal replacement therapy. With daily physiotherapeutic care, the patient was constantly mobilized. In the end, the most likely cause of the ventricular fibrillation and cardiac arrest was assumed to be mixed intoxication with the aforementioned medication. Because of this, there was no indication for ICD therapy. Overall, the patient could be discharged with a mild critical-illness polyneuropathy but no cerebral nor relevant neurological limitations into rehabilitation 18 days after cardiac arrest lasting several hours under hypothermia (Figures 1-5).

Discussion and conclusion

The criteria for the indication and decision of an eCPR are difficult. Parameters that have a positive prognostic effect and tend to be suggested for a decision on eCPR have already been mentioned in the sections above. In our case, there were actually many things speaking against the use of an extracorporal cardiac assist devise. The event leading to cardiac arrest happened unobserved, the duration of the no / low flow time was completely unclear here. Adequate resuscitation was presumably only delayed, especially if one considers the already extremely low body temperature after the patient has cooled down for seemingly a long time. All other parameters also ultimately spoke against eCPR (pH 6.6; SpO2 41.7%, lactate 10). Nevertheless, due to the young age of the patient and the extremely low body temperature as well as the persistent ventricular fibrillation, we decided to initiate maximum invasive therapy in this acute situation.

Clinical outcome remains one of the most challenging worships in critical care medicine since not only secondary protection of peripheral organ function remains the goal, the prediction of neurological outcome remains our “pandoras box” whether patients will ever completely recover.

In our Marburg Cardiac Arrest Center we treated over 750 patients since 2013 with OHCA and developed a clinical algorithm for a maximum cerebral protection which includes a phase of hypothermia (34°C) for at least 24hrs followed by a phase of normothermia for at least 72hrs, respectively. Cooling all of our patients using the indicated algorithm, we presented recently favourable results compared to larger eCPR centres.

Nevertheless, the best time starting targeted temperature management (TTM), the duration and the target temperature itself which should be selected in this situation are currently discussed in this regard. So far, multiple randomized trials provide controversial results whether and how cooling will be effective to prevent detrimental neurological outcome or not [8].

Taken together, in this case we could impressively show the importance of profound cerebral cooling in OHCA patients. It is urgent time for further evaluation and definition of targeted temperature management (TTM) improving the poor neurological outcome of these patients.

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