

Extracorporeal Cardiopulmonary Resuscitation for an Out-of-Hospital Cardiac Arrest

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ABSTRACT

Extra corporeal membrane oxygenation (ECMO) for refractory out-of-hospital cardiac arrest (OHCA) has been shown to improve outcome in many Western countries. There are no reports of ECMO being used to support OHCA in India till date. We report a case of a young man who developed cardiac arrest (CA) while driving and was given bystander cardiac massage. He was brought to tertiary care center where an ECMO was utilized for refractory CA. The patient subsequently underwent emergency coronary artery stenting and was weaned off ECMO and ventilation. We discuss the case and highlight the role of bystander cardiopulmonary resuscitation.

Keywords: Extra corporeal membrane oxygenation, out of hospital cardiac arrest, coronary stenting

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INTRODUCTION

Survival after out-of-hospital cardiac arrest (OHCA) is dismal even in countries with well-organized health-care systems. Extracorporeal cardiopulmonary resuscitation (E-CPR) is a specialized technique that has shown beneficial effects in improving outcome in patients with OHCA. However, in a country like India, with its teeming population, congested roads and limited public knowledge of CPR, by-stander CPR and reaching a hospital in time for E-CPR is only a remote possibility. This is the first case report in our country of a refractory cardiac arrest (CA) being salvaged with the use of E-CPR.

CASE HISTORY

A 39-year-old taxi driver suddenly collapsed while driving on a busy street. A passerby who happened to be an

ambulance driver saw him slumped over the wheel and dragged him into the back of the taxi and started cardiac massage. There was irregular shallow breathing at this time. Another Samaritan joined the first rescuer and supported him with the cardiac massage. The first rescuer then took the car and brought him to the nearest hospital, a quaternary care center.

On arrival, the emergency team took over the cardiac massage. His initial rhythm was ventricular fibrillation. Advanced cardiac life support (ACLS) protocols were initiated. During the next 15 min, the patient achieved “return of spontaneous rhythm” (ROSC) twice, but failed to sustain this. At this point, the Emergency Department (ED) consultant, took the decision to call for the extra corporeal membrane oxygenation (ECMO) team. While the team assembled, the risks and benefits of

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giving the patient a chance of survival with ECMO was discussed with the family and consent taken. 20 minutes after arrival in the ED, the ECMO team started establishing a veno-arterial ECMO (VA-ECMO) through a surgical cut down using both femoral regions.

Cardiac massage was continued, the patient was intubated and a central line placed. ROSC was established and lost multiple times. An echocardiogram during one of the ROSC periods showed significant anterior wall hypokinesia. This was confirmed with an electrocardiogram (ECG) taken at the same time. A heparin dose of 4000 units was given immediately. The cardiac catheterization laboratory was also alerted for rescue angioplasty. ROSC was finally established 26 min after arrival in the ED but the systemic pressures remained low.

ECMO was established 32 min after initiation (47 min after arrival in ED) through a 20 Fr arterial cannula placed through the left femoral artery and a 22 Fr long venous cannula placed from the right femoral vein into the right atrium. A Rotaflo console (Macquet, Getinge, Germany) was used for the ECMO system. An ECMO flow of 4.5 L. min was established. The inspired oxygen concentration (FiO₂) was initiated at 50%, which was then increased to achieve an arterial saturation of 95-97%. Once ECMO was established, the patient was cooled to 34°C using ice cold saline and the ECMO system.

The patient was shifted to the catheterization laboratory where a near total block in the left anterior descending artery was diagnosed. The left anterior descending (LAD) was stented with an everolimus eluting coronary stent (Xience Xpedition, Abbot, CA, USA).

A distal perfusion cannula was placed in the left femoral artery under ultrasound guidance using an 8 Fr cannula. This cannula was used for distal perfusion of the left limb. An intraaortic balloon pump (IABP) (Arrow International, PA, USA) was placed through the right femoral artery to “off load” the left ventricle. The patient was shifted to the cardiac surgical intensive care unit after the procedure.

His anticoagulation was managed with heparin infusion under activated partial thromboplastin time guidance. He was also placed on dual antiplatelet therapy. The patient did not have excess bleeding. He was rewarmed after 18 h and woke up without any neurological deficits. The ECMO was weaned off after 66 h. A precautionary tracheostomy was done on postoperative day 2. The IABP was removed on POD 4. He was weaned off the ventilator on POD 5 and the tracheostomy removed after another 3 days.

DISCUSSION

Survival after out of hospital CA is associated with dismal outcome even in developed countries.^[1] In an overpopulated and largely uneducated country like India, chances of survival after a CA in a crowded street is unlikely. This is probably the first case report of a refractory OHCA patient surviving after E-CPR.

Good neurological outcome following OHCA can only be realistic if bystander CPR and defibrillation is initiated immediately. An observational study on OHCA in a Western country showed that bystanders initiated CPR only in 49% of patients with CA.^[1] Of these, just 13.4% received defibrillation. In our case, the bystander happened to be an ambulance driver, trained in CPR. Public education on CPR is very common in this state and the people are aware of basic care required in a collapsed patient. This significantly helped in initial cardiac support and rapid transfer of patient to the hospital.

E-CPR has a role in patients with refractory CA, defined as “inability to sustain ROSC during ACLS”. Definition of refractory CA varies between 10 and 30 min although E-CPR is generally advocated after 15–20 min of refractory CA.

ECMO for in-hospital CA has been shown to be associated with better short- and long-term outcomes.^[2] Single center studies have highlighted the utility of E-CPR in patients with out-of-hospital refractory CA.^[3] In a prospective study of E-CPR in 26 patients (11 OHCA and 15 IHCA patients), a significant recovery to discharge (with full neurological recovery) was achieved in 60% in IHCA and 45% in OHCA patients.^[4] These authors attributed their high success to a combination of E-CPR along with therapeutic hypothermia and mechanical CPR.

In contrast, a European Society of Cardiology Registry showed that E-CPR for OHCA was not associated with better outcome as compared to conventional CPR (8.4% in E-CPR versus 8.6% in conventional CPR).^[5] Even when the authors tried to account for known confounders, they were not able to show a superiority of E-CPR on multivariate analysis or on propensity matching. The 2019 American Heart Association focused update on advanced cardiac life support mentions that there is insufficient evidence for the routine use of E-CPR in CA patients.^[6] However, it may be considered in selected patients if it can be implemented expeditiously and supported by skilled providers.

E-CPR can only be done in hospitals that are well equipped and have a regular ECMO program. A full contingent of

skilled expertise in the form of intensivists, anesthesiologists, cardiac surgeons, cardiologists, perfusionists and nurses are part of the program. A crucial factor in the success of an E-CPR program is the timing of decision-making. This usually falls on the shoulders of the ED physician who has to know the “no flow” time (time from CA to when massage was initiated), the efficacy of CPR, the initial rhythm, financial status of patient, the logistics of where to perform the procedure and whether there is non-sustained ROSC achieved during initial resuscitation. Favorable factors associated with successful E-CPR include age <65 years, witnessed arrest, an initial shockable rhythm, good quality immediate CPR (<5 minutes), intermittent CPR and no major comorbidities.^[4,5,7]

The patient in this case was a young and apparently “normal” active person with no comorbidities. In the CHEER study, the median time between CA and initiation of ECMO was 20 min and between CA and ECMO initiation was 56 min.^[4] In our patient, ECMO was initiated 32 min after calling the ECMO team and 47 min after the patient’s arrival in the ED. In spite of the longer time to ECMO, the excellent neurological outcome in our patient could be attributed to the excellent CPR continued through till initiation of ECMO.

We utilized therapeutic hypothermia for cerebral protection. Intravenous ice-cold saline and the cooling unit on ECMO were used to achieve the temperature of 34°C. Although the CHEER study used “on field” therapeutic hypothermia, a recent large study could not substantiate the benefits of therapeutic hypothermia during CA.^[8]

In patients with OHCA, it is mandatory that we identify a precipitating cause. Normally, acute coronary artery syndrome and pulmonary embolism are the most common causes.^[6,7] In this case, the restoration of flow through the anterior descending coronary artery improved myocardial contractility immediately.

Pre-hospital initiation of ECMO for OHCA may be associated with higher survival and better neurological outcome.^[8,9] This may be due to the shortened time between CA and initiation of ECMO.^[9] However, pre-hospital ECMO is very challenging, as it needs a larger team of experts who are comfortable at vascular cannulation under adverse conditions.

The use of E-CPR in refractory CA may also have additional advantages. E-CPR may be used as a bridge to transplantation or as a bridge to switch to a left ventricular assist device. In the European registry study on E-CPR for

OHCA, 4% of the patients who developed brain death were candidates for organ transplantation.^[5]

E-CPR is still not readily acceptable for routine use in CA patients.^[5,10] In an editorial, MacLaren *et al.*^[10] commented that E-CPR should be restricted to patients with shockable rhythm who achieve transient ROSC. This is very important, as a shockable rhythm indicates the potential for reversibility.

E-CPR provides the highest level of circulatory support during a CA. However, a number of ethical issues surround this technique. Who should be offered E-CPR in an emergency situation and what should be done when a patient on ECMO does not show a “positive response” in a few days? These are ethical issues for which we still do not have evidence-based answers. Lack of adequate time for a detailed discussion with an emotionally upset family during a CA can lead to an ambiguous situation subsequently, when the patient is alive but difficult to wean off the ECMO. Unlike situations where death is more clearly defined, as after a cardiac or respiratory arrest, the line that defines “death” becomes blurred for a patient who is on ECMO with circulatory and ventilator support. As there are no defined guidelines on this, the family and clinician will be stressed to decide as to when the support systems should be terminated. More alarming is the situation when the patient is neurologically intact but “nowhere to go”, if there are no facilities for a cardiac transplant or are ill affording for a more durable cardiac assist device. Moreover, inappropriate use of E-CPR can result in significant organ damage including brain injury, which can result in considerable emotional strain on the family and the healthcare system. If the outcome of E-CPR is genuinely below 10%, as shown in the European registry, the resource drain can be crippling. With more experience and further studies, these issues can be addressed in future.

In conclusion, we present the first reported case of a successful E-CPR in our country. The patient was a young healthy individual with no apparent comorbidity. Early bystander CPR, immediate shift to a tertiary care center, quick thinking on the ED team, and a well-trained ECMO team is the success of the story. E-CPR can be used judiciously even in our country, provided the case is chosen carefully and in a set up with adequate expertise.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will

not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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