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Extracorporeal life support for refractory out-of-hospital cardiac arrest: Should we still fight for? A single-centre, 5-year experience☆

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ABSTRACT

Background: Cardiopulmonary resuscitation displays low survival rate after out-of-hospital cardiac arrest (OHCA). Extracorporeal life support (ECLS) could be suggested as a rescue therapeutic option in refractory OHCA. The aim of this report is to analyze our experience of ECLS implantation for refractory OHCA.
Methods: We performed a retrospective observational analysis of our prospectively collected database. Patients were divided into a shockable rhythm (SH-R) and a non-shockable rhythm (NSH-R) group according to cardiac rhythm at ECLS implantation. The primary endpoint was survival to hospital discharge with good neurological recovery.
Results: From January 2010 to December 2014 we used ECLS in 68 patients (SH-R, $n = 19$, 27.9% vs. NSH-R, $n = 49$, 72.1%) for refractory OHCA. The clinical profile before ECLS implantation was comparable between the groups. Eight (11.7%) patients were successfully weaned from ECLS (SH-R = 31.5% vs. NSH-R = 4.0%, $p = 0.01$) after a mean period of support of 2.1 days (SH-R = 4.1 days vs. NSH-R = 1.4 days, $p = 0.01$). Six (8.8%) patients survived to discharge (SH-R = 31.5% vs. NSH-R = 0%, $p = 0.00$). In the SH-R group 50% of the survivors were discharged without neurological complications.
Conclusions: ECLS for refractory OHCA should be limited in consideration of its poor, especially neurological, outcome. Non-shockable rhythms could be considered as a formal contraindication allowing a concentration of our efforts on the shockable rhythms, where the chances of success are substantial.

1. Introduction

Out-of-hospital cardiac arrest (OHCA) still represents a leading cause of death worldwide and its incidence is not decreasing over time [1]. Conventional cardiopulmonary resuscitation (CPR) displays low survival outcome after OHCA. However, extracorporeal life support (ECLS) could be suggested as a rescue therapeutic option for refractory OHCA, i.e. the lack of return of spontaneous circulation (ROSC) within a period of at least 30 min of CPR under medical direction in the absence of pre-existing hypothermia [2].

ECLS showed promising results in the specific setting of in-hospital cardiac arrest (IHCA) and survival rates with good neurological outcome are reported between 20% and 40% [3–14]. On the basis of these findings, ECLS may be considered when the cardiac arrest period before CPR initiation is brief and the condition leading to cardiac arrest is reversible or amenable to subsequent interventions such as heart transplantation or revascularization [15]. Conversely, there are contrasting data in the literature about survival after ECLS for OHCA [4,8,10–14,16–24]. Moreover the results obtained with ECLS for IHCA could not be extended to OHCA in consideration of a different profile and management of these patients [8,10–14].

So the aim of the present report is to analyze our single-centre experience of ECLS utilization for refractory OHCA over a 5-year time period.

2. Methods

2.1. Setting

The city of Lyon is located in the Middle East France and has an area of 50 km^2. Lyon has a population of approximately 500,000 while its metropolitan area reaches a population of 2,200,000. Our Department of Cardiac Surgery is located in a university hospital. It is the regional

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referral centre for adult and pediatric mechanical circulatory support and heart transplantation with about 100–120 ECLS implantation/year for cardiogenic shock and refractory cardiac arrest.

2.2. Study design

We performed a retrospective observational analysis of our prospectively collected database of ECLS utilization for refractory OHCA at our institution over a 5-year time period. Approval of the Institutional Review Board of our hospital was obtained. Written informed consent for every data analysis was not obtained according to French legislation because this observational study did not modify existing diagnostic or therapeutic strategies.

2.3. Inclusion and exclusion criteria

Patients who received an ECLS for witnessed, refractory, OHCA from January 2010 to December 2014 were included in this analysis. We did not consider patients: 1) referred to our Department of Cardiac Surgery for ECLS support for refractory IHCA; 2) or cardiogenic shock following OHCA and ROSC; 3) experiencing severe hypothermia (body temperature < 32 °C) before CPR; 4) aged <18 years. At the beginning of our experience we did not consider an upper age limit as an exclusion criterion whereas the implantation of ECLS for refractory OHCA has been restricted to patients aged between 18 and 55 years since August 2012. This revision of the decision-making algorithm was decided following an interim national analysis of the results of ECLS for refractory OHCA, showing poor outcome in the subset of older patients. Pre-existing, known irreversible neurological damages or major comorbidities – such as terminal malignancy – compromising short-term (<1 year) life expectancy were absolute contraindications.

2.4. Study protocol

Our decision-making algorithm for the implantation of ECLS in case of refractory OHCA complied with national recommendations [2]. OHCA was firstly managed by bystanders performing CPR and thereafter by the emergency medical service team using international guidelines. When the emergency medical service team considered CPR as ineffective, our Department of Cardiac Surgery was then contacted in order to check the availability of a surgical team and to discuss the indication to the implantation of ECLS. The final indication of ECLS for refractory OHCA was confirmed if the following criteria were fulfilled: 1) no-flow time ≤5 min; 2) low-flow time ≤75 min (≤100 min from January 2010 to July 2012; this revision of the decision-making algorithm was also decided following the results of an interim national analysis of ECLS for refractory OHCA, showing poor outcome in the subset of patients with longer CPR duration); 3) end-tidal carbon dioxide (E_TCO_2) ≥10 mmHg. Neither transesophageal echocardiography nor routine laboratory tests were used in this decision-making algorithm. The patient was then transferred directly to our operating theater and CPR was continued using an automated device (AutoPulse; Zoll Inc., Chelmsford, MA, USA). Automated chest compression was continued until the start of ECLS support.

Our ECLS team included: 1) a senior cardiac surgeon and a resident in cardiac surgery for the implantation of the temporary mechanical circulatory support; 2) an anaesthesiologist of our Department of Anesthesia and Intensive Care Unit (ICU) for the perioperative medical management of the patient; 3) a technician for the preparation and priming of ECLS; and 4) two nurses assisting the surgical team during ECLS implantation. The implantation of ECLS was performed in a surgical manner. The venous (Maquet, Rastatt, Germany; 25 and 29 French) and arterial (Maquet, Rastatt, Germany; 15, 17 and 19 French) cannulae were placed using a modified Seldinger technique after surgical dissection and exposure of the femoral vessels at the groin. An arterial catheter was systematically placed distally to the entry site of the arterial cannula to prevent lower limb ischemia. The ECLS system is composed of venous (drainage) and arterial (reinjection) heparinized polyvinyl chloride tubing, a membrane oxygenator (Quadrox Bioline, Jostra-Maquet, Orléans, France), a centrifugal pump (Rotaflow, Jostra-Maquet, Orléans, France) and an oxygen/air blender (Sechrist Industries, Anaheim, CA, USA). At the end of the procedure, after final equipment (arterial and central venous catheter placement) and hemodynamic and respiratory stabilization, patients were transferred to the catheterization laboratory to perform a coronary angiography and, if required, percutaneous myocardial revascularization. If coronary angiography was normal, the patient underwent cerebral, thoracic and abdominal computed tomography in order to find other causes of cardiac arrest such as pulmonary embolism, aortic dissection or haemorrhagic stroke. At the admission to our ICU, therapeutic hypothermia (target body temperature of 33 °C) was maintained during the first 24 h using a heat exchanger connected to the ECLS system. Unfractioned heparin was not administered during ECLS implantation because of the presence of coagulation abnormalities but it was started in ICU after evaluation of standard coagulation laboratory exams. During ECLS support target activated clotting time was maintained 2.0 times higher than control. Neurological evaluation was performed after a 24-h period of mild hypothermia. Serial transoesophageal echocardiography controls were performed after progressive reduction of pump flow to assess the possibility to wean the patient from the mechanical support. Patients stable during reduction trials and with left ventricular ejection fraction >25% and time-velocity integral >10 cm were weaned from ECLS [25]. Successful weaning was defined as ECLS decannulation without the need for reinsertion of ECLS or mortality within 48 h. If the weaning trial was not hemodynamically tolerated and the echocardiographic criteria were not met, patients with complete neurological recovery were directed to heart transplantation or long-term ventricular assist device implantation depending on age, general clinical and functional status, life expectancy and end-organ (respiratory, hepatic and renal) function. Conversely, ECLS support was stopped in the presence of multiple organ failure (MOF) or brain death.

2.5. Outcome and statistical analysis

Demographics, pre-implantation, perioperative and post-implantation data were retrieved and collected from the computerized medical charts of our hospital. Patients were also divided into a shockable rhythm (SH-R; ventricular fibrillation and pulseless ventricular tachycardia) and a non-shockable rhythm (NSH-R; asystole and pulseless electrical activity) group according to cardiac rhythm at ECLS implantation. The primary endpoint of our study was survival to hospital discharge with good neurological recovery after ECLS support. The neurological assessment was performed using the Glasgow–Pittsburgh Cerebral Performance and Overall Performance Categories (CPC) score and good neurological recovery was defined as CPC score of 1 or 2 on a 5-point scale (1 = good cerebral performance, 2 = moderate cerebral disability, 3 = severe cerebral disability, 4 = coma or vegetative state, 5 = brain death or death) [26]. The secondary endpoints were successful ECLS implantation, successful weaning rate from ECLS support, ICU and total hospital length of stay. Statistical analysis was performed utilizing SPSS software, version 19.0 (IBM Corp., Armonk, NY, USA). Continuous variables were presented as mean ± standard deviation and compared using Student's t-test or Mann–Whitney U-test depending on their normality, which was assessed by the Kolmogorov–Smirnov test. Categorical variables were presented as counts and percentages and compared using Pearson's chi-squared test or Fisher's exact test, as appropriate. A bilateral p value of <0.05 was taken to indicate statistical significance.