CASE REPORT
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Extracorporeal cardiopulmonary resuscitation for failed cardiopulmonar resuscitation: the future has arrived. Case report

Resucitación cardiopulmonar extracorpórea en caso de reanimación cardiopulmonar fallida: el futuro ha llegado. Reporte de caso

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ABSTRACT

Cardiopulmonary resuscitation represents the gold standard in the management of cardiac arrest and/or sudden death; however, there is a significant number of potentially recoverable patients who do not respond to this treatment. Recent evidence of the utilization of percutaneous extracorporeal circulation as the last resource for the resuscitation of potentially recoverable patients in whom traditional cardiopulmonary resuscitation fails has shown promising results. We present a case of success of extracorporeal cardiopulmonary resuscitation for refractory cardiac arrest.

Keywords: cardiac arrest, sudden death, cardiopulmonary resuscitation, extracorporeal cardiopulmonary resuscitation, extracorporeal membrane oxygenation, extra-corporeal life support.

RESUMEN

La reanimación cardiopulmonar representa el estándar de oro en el manejo del paro cardíaco y/o muerte súbita; sin embargo, existe un número significativo de pacientes potencialmente recuperables que no responden a este tratamiento. Evidencias recientes de la utilización de la circulación extracorpórea percutánea como último recurso para la reanimación de pacientes potencialmente recuperables, en quienes la reanimación cardiopulmonar tradicional falla, han mostrado resultados prometedores. Presentamos un caso exitoso de reanimación cardiopulmonar extracorpórea para paro cardíaco refractario.

Palabras clave: *paro cardíaco, muerte súbita, reanimación cardiopulmonar, reanimación cardiopulmonar extracorpórea, oxigenación por membrana extracorpórea, soporte vital extracorpóreo.*

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Cardiac arrest (CA) defined as the loss of mechanical function of the heart is a frequent cause of death and a major public health problem with an incidence in North America and Europe that approximates 50 to 100 cases per 100,000.[1,2] In Hospital Cardiac Arrest (IHCA) has a reported incidence in Europe of 1 to 5 per 1,000 admissions with an overall survival rate of 23%.[3] Response to IHCA or ventricular fibrillation has developed over time and now triggers the presence of a team of specially assigned and trained first responders. Different cardiopulmonary resuscitation (CPR) techniques have evolved based on compelling scientific evidence, establishing universally standardized processes that have guaranteed the best possible results; always depending on the clinical scenario of each patient.

Modern cardiac surgery was developed primary by the invention of the heart-lung machine by Dr. John Gibbon in 1953, which allows full body perfusion with an arrested heart.[4] This technology has evolved and has benefited from the miniaturization of both equipment and cannulas for vascular access, as well as the manufacture of better membranes for gas exchange that can support patients properly for long periods of time.

When consulted to treat individuals with history of "in hospital" sudden death (SD) or CA, especially "a witnessed event" in patients who, both due to their age and general health condition could be categorized as "potentially recoverable", abandoning conventional CPR after several failed attempts; today represents "not having offered all the available therapeutic options". With the development of percutaneous cannulas and compact extracorporeal circulation systems, as well as the new multidisciplinary teams of health professionals trained to perform these procedures, we can support and rescue patients with peripheral cardiopulmonary bypass frequently using extracorporeal membrane oxygenation (ECMO) creating a new window of therapeutic opportunity.[5]

Also patients with terminal heart or lung diseases who develop cardiorespiratory arrest in which conventional CPR fails and fully rescued by the successful application of cardiopulmonary bypass can allow us in case of heart disease to reconvert the cardiac ECMO circuit towards sophisticated ventricular support devices either for bridge to heart transplantation and/or for destination therapy; and in the case of terminal pulmonary patients, they can remain on cardiac ECMO or reconvert the system to respiratory ECMO so that the system allows the bridge to lung transplantation.[6]

CASE DESCRIPTION

We present herein the case of a 63-year-old female patient with past medical history of type 2 diabetes mellitus, hypothyroidism, and anterior myocardial infarction (AMI) in 2014. In 2023, she presented with a second AMI associated with cardiogenic shock. She was treated with percutaneous coronary intervention, intra-aortic balloon pump (IABP), endotracheal intubation and vasopressors. At the same time, she was diagnosed as bilateral pulmonary emboli. After 11 days, she was discharged at home stable, with left ventricle ejection fraction (LVEF) of 20%, treated with conventional medical therapy for heart failure with reduced ejection fraction, oral anticoagulation and supplementary oxygen.

In early June 2024, she arrived at the emergency room after one week of suffering progressive dyspnea, orthopnea, and swelling of the lower limbs. Cardiopulmonary examination with bilateral hypoventilation at lung auscultation and fine rales in the right lung. Cardiac auscultation with systolic murmurs in mitral and tricuspid foci. Rest of the physical examination without abnormalities.

The electrocardiogram evidenced irregular rhythm with ventricular pace of 55 bpm, with absence of P waves. Transthoracic echocardiogram showed LVEF of 25%, PSAP (pulmonary artery systolic pressure) 65 mmHg, without organized auricular activity, ventricular dyskinesia, severe mitral and tricuspid insufficiencies. Blood labs with BNP (B-type natriuretic peptide) 2,751, rest without alterations.

Thoracic posteroanterior X-ray presented diffuse interstitial thickening, suggestive signs of pleural effusion and cardiomegaly. She was diagnosed with heart failure NYHA III and severe mitral and tricuspid insufficiencies.

Conventional medical management was initiated and further on an automated implantable cardioverter-defibrillator (AICD) was successfully placed. Despite initial management,

Figure 1:

Extracorporeal cardiopulmonary resuscitation (ECPR) with a Cardiohelp System (Getinge AB, Sweden).

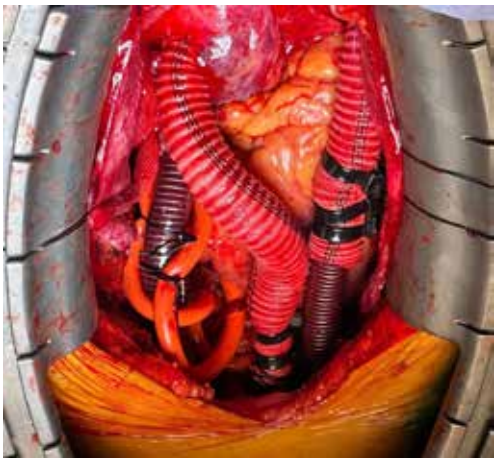

Figure 2: Central cannulation for biventricular support.

the patient deteriorated and presented with electromechanical dissociation (despite AICD) and resuscitation was achieved with the placement of and IABP, medical management and mechanical ventilation.

Twenty-four hours later, after being stable, she presented "witnessed" sudden ventricular fibrillation non-responsive to the AICD therapy and conventional CPR. After 40 minutes of failed CPR, extracorporeal cardiopulmonary resuscitation *(Figure 1)* was successfully established by removing the IABP in the right femoral artery for arterial outflow access and a left femoral vein previous central line for the extracorporeal life support (ECLS) venous inflow. After 8 hours we performed a neurological evaluation and no evidence of neurological damage was observed. ECLS flows were enough (average 3 liters/min) to sustain adequate organ perfusion; however, echo showed practically no left ventricular function.

With the patient's cardiac medical history and the recent events, we decided that her best option was to upscale the circulatory assistance and she underwent the successful implant of biventricular mechanical para corporeal cardiac support with a dual Centrimag axial flow system (Levitronix GmbH, CH-8048 Zurich, Switzerland).

Central Cannulation was performed under cardiopulmonary bypass (using the femoral ECLS device as CPB), with angled 32 Fr cannulae for the left and the right atrium and 12 Fr grafted cannulae for the aorta and pulmonary arteries *(Figures 2 and 3)*.

The patient had an uneventful recovery, she was extubated, starting to ambulate awaiting further evaluation and be listed for cardiac transplantation.

COMMENT

It has been a long way since the first publication of the Advanced Cardiovascular Life Support program (ACLS) by the American Heart Association in 1975.[7] CPR procedures have scientifically evolved and it's results have shown today that close to 25% of patients suffering from cardiac arrest in a hospital environment can be saved. Likewise, the widespread instruction of universal CPR techniques for health and non-health professionals in the prehospital environment have resulted in better survival rates.[1,8,9]

Nevertheless, in both scenarios, a subset of patients exists who remain potentially recoverable despite the failure of conventional CPR. Within this subgroup, extracorporeal cardiopulmonary resuscitation (ECPR) has demonstrated remarkable efficacy.[8]

The continuous improvement of cannula for percutaneous peripheral ECLS has provided the opportunity for trained multispecialty professionals to cannulate the patients. Also, it is a known fact that many of these procedures are performed in critically ill patients where the operator skill is important, and even some patients have to be cannulated in the Intensive Care Unit with only ultrasound and/or echo guidance. In the case of ECPR the conditions turn out to be more difficult because the patients are cannulated when undergoing chest compressions and during failed CPR. Initial success will depend on the hospital's cumulative experience with this type of procedures and the 24/7 availability of a "rapid-response team".

In our country, despite the fact that we started the application of ECLS techniques in the early 1990's, it was limited to only a few centers and mainly used for post

Figure 3: Biventricular mechanical extracorporeal cardiac support with a dual CentriMag axial flow system (Levitronix GmbH, CH-8048 Zurich, Switzerland).

cardiotomy and failed angioplasty cases. The COVID-19 pandemic forced us to integrate many more "rapid-response teams" in most large reference centers, and cases multiplied to such numbers that this teams traveled by land or air long distances to rescue critically ill patients and transferred them on ECMO to our and other experienced facilities; thus turning the clinical use of ECLS from the "once in a while monster case" to a routine everyday procedure.[10]

However, and despite our long and extensive experience with cardiopulmonary support and ventricular assist devices, aside from post cardiotomy cases, failed cath-lab procedures and ventricular assist devices implantation, most cases were planned or elective. We had not established before ECPR as a standard 24/7 procedure.

CONCLUSIONS

The case described above demonstrates again the success of ECPR for failed conventional CPR and that can be safely done on a third level general community hospital. We hope that with the implementation of this new program, ECPR success cases will grow and in a near future or Raid Response Team will be able to perform successful ECPR in Non-Hospital Environment as it has been done in other countries.[11]

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