Resuscitation 84 (2013) 609–615

Contents lists available at SciVerse ScienceDirect

Resuscitation

journal homepage: www.elsevier.com/locate/resuscitation

Clinical paper

Percutaneous left ventricular assistance in post cardiac arrest shock: Comparison of intra aortic blood pump and IMPELLA Recover LP2.5☆

Stéphane Manzo-Silberman[a,c,*,f], Jérôme Fichet[b,d,f], Armelle Mathonnet[b], Olivier Varenne[a], Sylvie Ricome[b], Aurès Chaib[a], Benjamin Zuber[b], Christian Spaulding[a,e], Alain Cariou[b]

[a] Cardiology Department, Cochin University Hospital (AP-HP) & Paris Descartes University (Medical School), 27 Rue du Faubourg Saint Jacques, 75014 Paris, France
[b] Medical Intensive Care Unit, Cochin University Hospital (AP-HP) & Paris Descartes University (Medical School), 27 Rue du Faubourg Saint Jacques, 75014 Paris, France
[c] Cardiology Department, Lariboisière University Hospital (AP-HP) & Paris VII University (Medical School), 2 Rue Ambroise Paré, 75010 Paris, France
[d] Medical Intensive Care Unit, Antoine Béclère University Hospital (APHP), 157 Rue de la Porte de Trivaux, 92141 Clamart, France
[e] Cardiology Department, HEGP University Hospital (AP-HP) & Paris Descartes University (Medical School), 20 Rue Leblanc, 75015 Paris, France

ARTICLE INFO

Article history:
Received 27 June 2012
Received in revised form
27 September 2012
Accepted 2 October 2012

Keywords:
Cardiac arrest
Post cardiac arrest syndrome
Cardiogenic shock
Left ventricle assist device
Intra aortic balloon pump

ABSTRACT

Aim: To compare the feasibility, safety and outcome of IMPELLA Recover LP2.5 cardiac assistance and intra aortic balloon pump (IABP) in patients with post-cardiac arrest shock.
Background: The high early mortality rate of post-cardiac arrest patients is attributed to a "post cardiac arrest syndrome" characterized by an acute and transient left ventricular (LV) systolic dysfunction. LV assistance with IMPELLA Recover LP2.5 is proposed in most severe patients.
Methods: Retrospective single center registry from January 2007 to October 2010. All survivors of out-of-hospital cardiac arrest with patent or predictive factors for the occurrence of post-resuscitation shock assisted by either IMPELLA or intra aortic balloon pump (IABP) device immediately after the coronary angiogram were included.
Results: 78 post-cardiac arrest patients were assisted by one of the devices (35 by IMPELLA and 43 by IABP). Median "no flow" and median "low flow" were similar at admission as were hemodynamic parameters. The feasibility of IMPELLA implantation was good (97%). At 28 days, the survival rate without sequellae was 23.0% in the IMPELLA and 29.5% in the IABP group ($p = 0.61$). Vascular complications were observed equally in both groups (3 vs 2, $p = 0.9$). Serious bleeding complications occurred in 26% of IMPELLA patients vs 9% of IABP patients ($p = 0.06$).
Conclusion: Early LV assistance by the IMPELLA LP2.5 is feasible in patients with post-resuscitation shock. The rate of complications did not differ substantially in the two groups, except for a trend toward a higher rate of bleeding events with IMPELLA. These encouraging findings must be confirmed in a larger clinical study.

1. Introduction

Out of hospital cardiac arrest (OHCA) still remains a major public health concern. The overall survival rate remains low and is critically related to the delay of initiation of resuscitation. Even in patients with successful resuscitation, the prognosis remains poor, due to cerebral ischemic injury and occurrence of post-cardiac arrest syndrome.[1] Post-cardiac arrest (CA) shock is characterized by a systemic ischemia/reperfusion syndrome but also by a low cardiac output provoked by a transient myocardial stunning. This may lead to shock, multiple organ failure (MOF) and death, even in patients with good neurological prognosis. In the setting of OHCA related to acute coronary syndrome (ACS), cardiac function is furthermore impaired in relation to the extent of necrosis. The cornerstone of the initial care is thus early reperfusion.[2] Providing early cardiac mechanical assistance after OHCA may unload left ventricle (LV) and increase cardiac output.[1,3] This strategy may

Abbreviations: ACS, acute coronary syndrome; CPC, cerebral Performance Category; CPR, cardio-pulmonary resuscitation; ECLS, extracorporeal life support; IABP, intra-aortic balloon pump; ICU, intensive care unit; LV, left ventricle/left ventricular; LVAD, left ventricle assist device; LVEF, LV ejection fraction; LVEDP, LV end diastolic pressure; MAP, mean arterial pressure; MOF, multiple organ failure; OHCA, out of hospital cardiac arrest; PCI, percutaneous coronary intervention; SOFA, Sepsis-related Organ Failure Assessment; TEE, transoesophageal echocardiography.

☆ A Spanish translated version of the abstract of this article appears as Appendix in the final online version at http://dx.doi.org/10.1016/j.resuscitation.2012.10.001.

* Corresponding author at: Service de Cardiologie, Hôpital Lariboisière (AP-HP) et Université Denis Diderot (Faculté de Médecine), 2 Rue Ambroise Paré, 75010 Paris, France. Tel.: +33 1 49 95 82 09; fax: +33 1 49 95 68 46.
E-mail addresses: stephane.manzosilberman@lrb.aphp.fr, stephanesilberman@hotmail.com (S. Manzo-Silberman).
[f] These authors contributed equally to this work and are co-first authors of this manuscript.

0300-9572/$ – see front matter © 2012 Elsevier Ireland Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.resuscitation.2012.10.001

even help in resolution of shock and limit further secondary cerebral injury related to hypoperfusion. Cardiac assistance may help to overcome the initial myocardial failure and thereafter enable secondary neurological evaluation. Extracorporeal life support (ECLS) has been proposed in refractory cardiac arrest and refractive shock but is technically complex and requires surgical approach.[4] Furthermore the cost-effectiveness of ECLS remains uncertain in this population at high risk for major brain damages. There is therefore a need for minimally invasive assistance devices in the setting of post-cardiac arrest shock. For years, intra-aortic balloon pump has been considered as adjunctive therapy in cardiogenic shock, especially during ACS.[6] This could be extended to post-CA shock despite the lack of current evidence.[5,6] The IMPELLA Recover LP2.5 (ABIOMED Europe GmbH, Aachen, Germany) was recently developed as a catheter-based miniaturized axial flow pump that may be inserted percutaneously. Safety and feasibility of IMPELLA LP2.5 has been previously evaluated in high-risk percutaneous coronary intervention (PCI)[7,8] and was also compared to IABP in a small trial of patients with cardiogenic shock.[9] In order to better evaluate the potential benefit of this left ventricular assist device in the very particular setting of post-CA patients, we report here our experience regarding outcome, feasibility and safety of the use of the IMPELLA LP2.5 compared to IABP.

2. Materials ands methods

The study was based on analysis of the PROCAT (Parisian Region Out of Hospital Cardiac Arrest) registry, which was previously described.[10] Patients were enrolled from January 2007 to October 2010 at the Cochin University Hospital (Paris, France), which is considered a specialized cardiac arrest center. All OHCA patients were managed by mobile emergency units, each staffed with a physician trained in emergency medicine. All pre-hospital survivors with no obvious extra-cardiac cause were directly admitted to the catheterization laboratory.[2,10,11] Immediate coronary and LV angiograms were performed, followed, when necessary, by an immediate PCI. A PCI is attempted if there is an acute coronary artery occlusion or if there is an unstable lesion that could be considered as the cause of cardiac arrest. As recommended, PCI was also performed in all critically stenosed large epicardial coronary arteries according to operator's evaluation and patient's hemodynamic status. Patients with shock or predictive factors for the occurrence of a post-CA shock were considered for percutaneous assistance insertion.

Patent post-cardiac arrest shock was defined by the need for continuous infusion of vasopressors (epinephrine or norepinephrine) to maintain a systolic blood pressure >90 mmHg despite adequate fluid loading.[11] Predictive factors for occurrence of post-CA shock were based on previous studies of OHCA survivors[12]: interval between the onset of OHCA and the return of spontaneous circulation >15 min, LV ejection fraction (LVEF) < 30% and LV end diastolic pressure (LVEDP) > 30 mmHg.

The exclusion criteria for implantation were severe peripheral vascular or aortic disease. Patients with refractory OHCA (CPR at the time of admission) were not considered for IABP or IMPELLA insertion.

Prior to the study period, IABP was the standard of care in these patients. On January 2007, IMPELLA LP2.5 was made available in the catheterization laboratory. At that time, operators were encouraged to include IMPELLA insertion as an alternative to IABP in patients with post cardiac arrest shock. As the superiority of IMPELLA was not known in the particular context of post-CA shock, the decision to insert either IABP or IMPELLA was made by consensus between the interventional cardiologist and the intensivist. The decision was based on individual parameters (severity of shock, instability during PCI, risk of bleeding, time of resuscitation) and on the experience of the operator. To investigate the safety and complications related to IMPELLA insertion, we compared these patients to OHCA patients that received IABP in the same period.

2.1. Implantation procedure

The IMPELLA LP2.5 (ABIOMED, Aachen, Germany) is a minimally invasive device that continuously aspires blood from the LV and expels it to the ascending aorta with a tri-directional flow in front of the coronary ostia. The performance depends on the rotary speed of the pump and the LV afterload, generating flows up to 2.5 L/min. IMPELLA LP2.5 directly unloads the left ventricle, reduces myocardial workload and oxygen consumption and increases cardiac output and coronary and end organ perfusion.[13–15] Implantation was performed by interventional cardiologists. The pump was inserted via a 13-F sheath in the femoral artery and placed retrogradely through the aortic valve after coronary angiography or later at bedside in the ICU under transoesophageal echocardiography (TEE) control. Before placement in the LV, the catheter was connected to the console. Pump rotation was started and gradually increased up to the maximal speed. The pump speed was then adjusted according to clinical, hemodynamic and biological parameters (systemic blood pressure, urine output and plasma lactate concentration). The decision to stop cardiac assistance was based on resolution of shock, switch to another assistance device and neurological evaluation. The speed was then decreased and the catheter was removed with manual compression of the femoral artery. In case of high puncture site or obesity, IMPELLA withdrawal was performed by a vascular surgeon.

IABP (MAQUET Datascope Corp., NJ, USA) insertion procedure is routinely performed using a percutaneous femoral approach (7 French) under fluoroscopic guidance. Insertion could be done at the beginning of the procedure or after coronary reperfusion depending of the hemodynamic status of the patient. The operating principle is based on sudden inflation during diastole of the balloon positioned in the descending aorta and its rapid deflation before systole. The kicker of diastolic pressure improved coronary blood flow and systemic perfusion. The blood is propelled into the coronary arteries at the time of left ventricle relaxation, which ensures optimal coronary perfusion. In addition, the better aortic diastolic drainage reduces left ventricular afterload. It leads to a drop in left ventricle trans-mural pressure, which combined with lower myocardial ischemia allows an increase in cardiac contractility and an increase in the volume of systolic ejection. The result is a decrease in LV end-diastolic pressure and reduced pulmonary pressures. Setting up intra-aortic balloon in post-myocardial infarction cardiogenic shock is nearly systematic before angioplasty in the context of cardiogenic shock.[6]

2.2. Patient management

After ICU admission, all patients were treated with mild hypothermia (32–34 °C) for 24 h as recommended by current guidelines.[16] Sedative agents and neuromuscular blockers were added during hypothermia phase. Epinephrine was used to obtain adequate mean arterial pressure (MAP > 65 mmHg). According to our practices, invasive cardiac output monitoring was not routinely performed. Bedside echocardiography was performed at admission and repeated daily. Arterial blood gas including arterial lactates and hemoglobin level were closely monitored. In front of refractory shock despite device insertion and medical optimization, peripheral ECLS implantation by a surgical team was considered.