
Impact of Mechanical Circulatory Support Timing on Outcomes in Myocardial Infarction-Related Cardiogenic Shock: Subanalysis of the PREPARE CS Registry

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Brief Report

Impact of Mechanical Circulatory Support Timing on Outcomes in Myocardial Infarction-Related Cardiogenic Shock: Subanalysis of the PREPARE CS Registry

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Abstract: (1) Background: Mechanical circulatory support (MCS) in myocardial infarction associated cardiogenic shock is subject to debate. This analysis aims to elucidate the impact of MCS timing on patient outcomes, based on data from the PREPARE CS registry.; (2) Methods: PREPARE CS prospective registry included consecutive patients experiencing cardiogenic shock (SCAI Classes C-E) and were referred for cardiac catheterization. Present analysis included a subset, in whom MCS was used and underwent coronary intervention due to myocardial infarction. Patients were categorized into Upfront group versus Procedural group, depending on the timing of MCS introduction in relation to PCI. Endpoint was the in-hospital mortality; (3) Results: In total 71 patients were included. MCS was started prior to PCI in 33 (46%) patients (Upfront), whereas 38 (54%) received MCS during or after PCI initiation (Procedural). Baseline characteristics and hemodynamic parameters were comparable. The Upfront group had a higher utilization of Impella® device compared to extracorporeal membrane oxygenation (67% vs 33%), while the Procedural group exhibited a balanced use (50% vs 50%). Most patients suffered of multi-vessel disease in both groups (82% vs 84%, respectively; $p=0.99$) and most patients required complex PCI procedure, the latter was more prevalent in the Upfront group (94% vs 71%, respectively; $p=0.02$). Rates of complete revascularization were comparable (52% vs 34%, respectively; $p=0.16$). Procedural CPR was significantly more frequent in the Procedural group (45% vs 79%, $p<0.05$), still in-hospital mortality was similar (61% vs 79%, respectively; $p=0.12$); (4) Conclusions: Upfront implantation of MCS in myocardial infarction associated CS did not provide in-hospital survival benefit.

Keywords: cardiogenic shock; mechanical circulatory support; myocardial infarction; mechanical circulatory support timing; in-hospital mortality

1. Introduction

Cardiogenic shock (CS) is characterized by a significant reduction in cardiac output, leading to inadequate end-organ perfusion resulting in multiorgan failure and consequently associated with extremely high mortality [1,2]. The predominant etiology of CS is acute myocardial infarction (AMI), which accounts for over 80% of cases and often precipitates critical dysfunction of the left, the right or both ventricles [3].

While mechanical circulatory devices (MCS) are considered as last resort for maintaining circulation in CS, recent trials have not shown any benefit remaining with limited evidence concerning their indication [4]. Data collected from randomized clinical trials regarding safety, efficacy and the optimal timing of MCS device delivery is scarce and the largest trials IABP-SHOCK II [5] and ECLS shock [6] failed to prove superiority of MCS use when considering survival rates [5]. Further safety concerns were raised considering stroke, major bleeding complications and mortality [7,8].

Still, despite not having any clear evidence to support a beneficial impact on clinical outcomes, MCS is widely used in the treatment of CS [9]. As the sole potential tool for maintaining systemic blood perfusion in patients with refractory CS, its utilization has generated conflicting data across various shock center registries. Nonetheless, this data does suggest that adhering to a standardized, multidisciplinary treatment algorithm for MCS implementation could lead to improved survival rates [10,11]. Still, the optimal timing for MCS initiation remains uncertain [11].

While RCTs are the best tool to generate scientific evidence, registries have the potential to shed new light on real world application. Considering these aspects, the aim of our present analysis was to understand, in the context of real-world setting, whether the timing of the MCS implantation correlates with short-term outcome. Analysis was performed based on the PREPARE CS Registry [12].

2. Materials and Methods

The PREPARE CS, a single-center prospective registry conducted from May 2019 to April 2023, enrolled all consecutive patients with cardiogenic shock as classified by SCAI stages C-E who were referred to the cardiac catheterization laboratory. Cardiogenic shock was identified based on criteria indicative of prolonged hypoperfusion and need for vasoactive medication for maintaining sufficient perfusion pressure [2].

In this analysis we focused on a subset in whom CS was confirmed to be caused by myocardial infarction, indicating PCI. In conjunction with coronary revascularization, all patients in the present analysis received adjunct MCS. According to our centers practice, MCS devices incorporated into this study were either the Impella® CP Heart Pump (Impella; Abiomed Inc., Danvers, MA, USA) or a veno-arterial extracorporeal membrane oxygenator (VA-ECMO; Xenios AG, Heilbronn, BW, Germany). Patients were categorized into two groups according to the timing of MCS relative to PCI: the 'Upfront' group, receiving MCS prior to revascularization, and the 'Procedural' group, receiving MCS at any time after the PCI has been started. The analyses primary endpoint was in-hospital mortality.

Statistical Analysis

All analyses were performed with Prism GraphPad 9.0 (GraphPad Software Inc., California, US). Summary descriptive statistics are reported as mean \pm SD or n (%), as appropriate. Normal distribution was tested by D'Agostino-Pearson omnibus normality test. Continuous variables were compared by Mann-Whitney tests or Kruskal-Wallis test and categorical variables were compared with Fisher's exact or chi-square tests, as appropriate. A probability value of $p < 0.05$ was considered as significant.

3. Results

Between May 2019 and April 2023 406 patients underwent percutaneous revascularization due to acute myocardial infarction associated CS (SCAI Classes C-E). Among these patients, any MCS was utilized in 71 (17%) cases.

In 33 (46%) of the cases, MCS was implanted before PCI (Upfront group), whereas in 38 (54%) of the patients, it was started at any point after the start of the procedure (Procedural group). In the Upfront group the mean age was 67 ± 10 years while in the Procedural group 62 ± 11 years ($p=0.05$). Both groups were mainly represented by male patients (76% vs 82%, respectively; $p=0.57$). Cardiovascular risk factors and baseline characteristics were found as comparable between the two groups. Table 1.

Table 1. Clinical characteristics. BMI: Body mass index; CABG: coronary artery bypass graft; CPR: cardiopulmonary resuscitation; OHCA: out of hospital cardiac arrest; PCI: percutaneous coronary intervention.

	Upfront Group	n=33	Procedural Group	n=38	p
	n / mean	% or SD	n / mean	% or SD	
Age	67	± 10	62	± 11	0.05
OHCA	8	25	10	28	0.99
Any CPR	15	45	30	79	<0.05
Female Gender	8	24	7	18	0.57
BMI	28	± 5	28	± 4	0.75
Hypertension	19	58	16	42	0.24
Dyslipidemia	11	33	8	21	0.29
Diabetes mellitus	6	18	11	29	0.40
History of PCI	5	15	6	16	0.99
History of CABG	2	6	2	5	0.99

In the Upfront group an Impella was more frequently used compared to ECMO (67% vs 33%). In the Procedural group the proportion was similar (50% vs 50%). Figure 1.

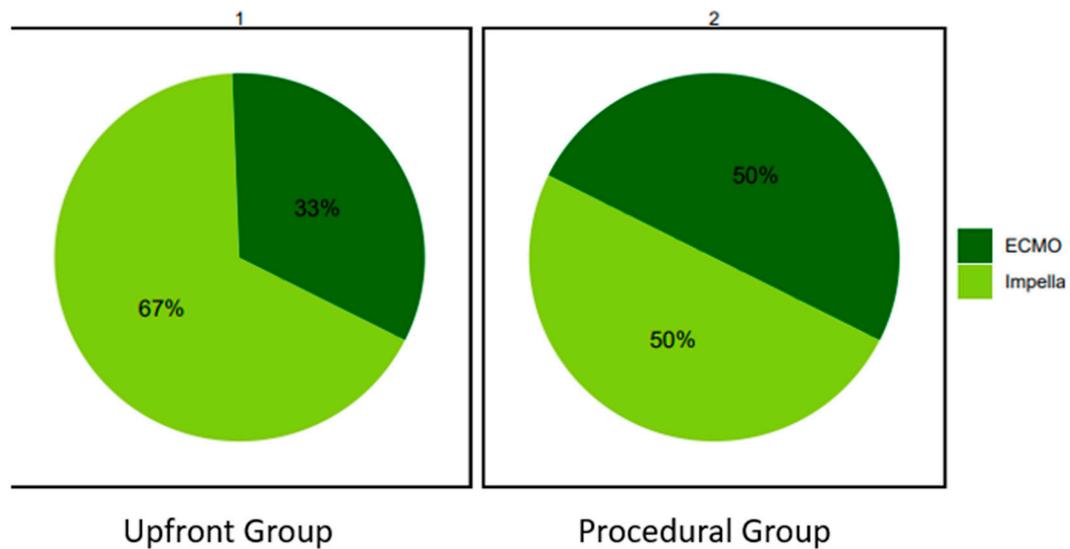


Figure 1. Distribution of Mechanical Circulatory Support usage in the Upfront and Procedural Groups. ECMO: extracorporeal membrane oxygenation.

The vast majority of patients had multivessel coronary artery disease (MVD) in both groups (82% vs 84%, respectively; $p=0.99$). However, MVD-PCI was performed only in 45% and 42%, respectively ($p=0.81$). Accordingly, complete revascularization has been achieved in 52% and 34% of the cases, respectively ($p=0.16$).

Complex coronary artery interventions, defined by extensive calcification, bifurcation lesion, large volumes of contrast use or prolonged procedural time, were performed in the majority of cases in both groups. However, these were more frequent in the Upfront group (94% vs 71%, respectively; $p=0.02$). Detailed procedural aspects are presented in Table 2.

Table 2. Procedural characteristics. ECMO: extracorporeal membrane oxygenation; MV: multivessel; PCI: percutaneous coronary intervention.

	Upfront Group n=33		Procedural Group n=38		p
	n / mean	% or SD	n / mean	% or SD	
Multivessel Disease	27	82	32	84	0.99
MV Disease PCI	15	45	16	42	0.81
Full Revascularization	17	52	13	34	0.16
Complex PCI Procedure	31	94	27	71	0.02
Bifurcation lesion PCI	16	48	10	26	0.08
Relevant Coronary Calcification (with need of special lesion preparation)	3	9	3	8	0.99
Contrast used (ml)	246	98	252	121	0.82

Procedure Duration (minutes)	142	62	134	60	0.59
Use of IMPELLA	22	67	19	50	
Use of ECMO	11	33	19	50	0.23
In-Hospital Mortality	20	61	30	79	0.12

Comparing patients with Upfront- versus Procedural MCS, periprocedural CPR was significantly more frequent in the latter (45% vs 79%, $p < 0.05$). Still, in-hospital mortality remained similar in both groups (61% vs 79%, respectively; hazard ratio 1.55 [0.93 to 2.46]; $p = 0.12$). Figure 2.

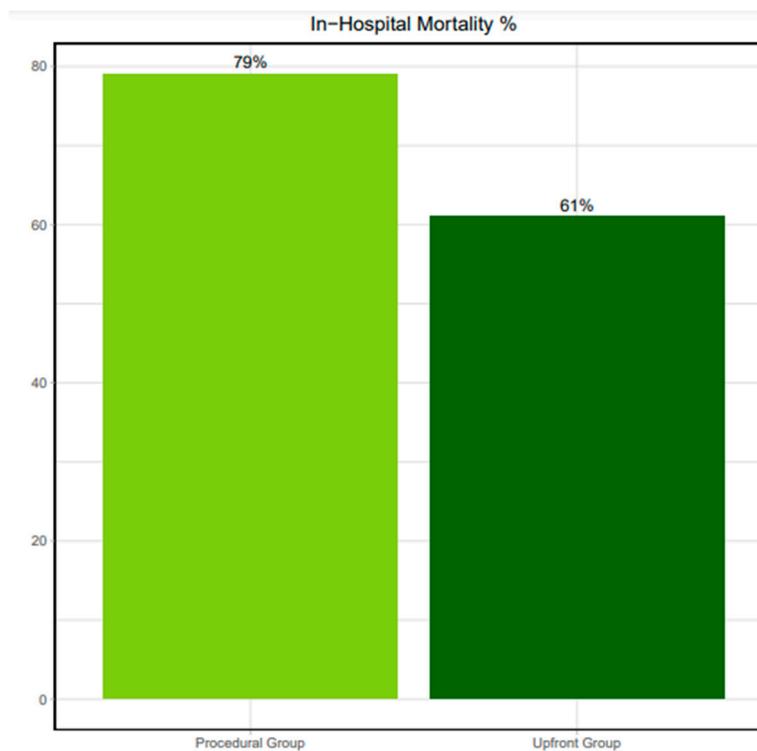


Figure 2. In-Hospital Mortality for the Upfront and Procedural Groups.

4. Discussion

Present data, including similar proportion of patients, who received the device either before or after the start of the PCI, suggest that timing of MCS implantation has no impact on in-hospital survival of patients with myocardial infarction-related CS.

Given these findings, coupled with the absence of definitive evidence or clear guidelines for MCS in AMI-related CS [13], several questions naturally arise that could influence decision-making in everyday practice. Firstly, the impact of MCS intervention on the acute phase of CS and its subsequent effects on prognosis and mortality remains uncertain. Secondly, the optimal timing for MCS deployment is still undetermined, lacking clear guidance from existing literature. Lastly, choice of the best available device [14,15] remains unclear. In light of these uncertainties, MCS currently holds a Class IIa recommendation in the European Guidelines [16].

Multiple RCTs have addressed the question of a potential benefit for the use of MCS devices in AMI patients [5,6,17,18]. Landmark ECLS-SHOCK trial, which addressed the impact of extracorporeal life support on mortality in patients presenting with MI complicated by CS, failed to demonstrate a benefit of MCS compared to medical therapy alone in terms of 30-days survival [6].

On the other hand, smaller studies suggest an association between early utilization of MCS and improved early hemodynamics, survival rates and prognosis in patients presenting with AMI-CS [19,20]. A further retrospective study conducted on 64 AMI-CS patients, randomized to IABP and Impella, showed that patients receiving Impella pumps before the PCI procedure, experienced a reduction in infarct size as well as an improved myocardial recovery at 6 months follow-up [21]. The same study highlighted the importance of an early MCS strategy in reducing reperfusion injury and left ventricular wall stress post-AMI, while reducing the need for high-dose inotropes. These advantages were particularly evident when accompanied by a lower rate of MCS-related complications.

The literature suggest that an early phase delivery of these devices was associated with improved clinical outcomes [22–24]. Moreover, reduction in mortality was reported by Basir et al [19] when MCS was initiated within 90 minutes after the onset of the cardiogenic shock. For STEMI patients presenting with CS, early diagnosis of the condition with a short time to coronary reperfusion, the so called “door to support” time, similar to the ‘time-is-muscle’ paradigm [25], is key for improving survival and became routine in the management workup [26]. Since a reduction in all-cause mortality was observed by implementation of MCS devices pre-PCI or even before initiation of vascular resuscitation, actual studies support the concept of door to support time in ACS-CS patients [27].

5. Limitations

An important limitation to our study was the relatively small number of patients. Given the non-randomized nature, device selection, as well as the timing of MCS delivery were at the discretion of the operators, resulting in certain treatment biases.

6. Conclusions

Real-life dataset did not show statistical benefit in in-hospital mortality, when MCS is introduced prior coronary intervention.

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