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Research Article

Impact of Intra-aortic Balloon Pump in Advanced Heart Failure and Cardiogenic Shock Pre and Post Heart Transplant

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Abstract

The use of the intra-aortic balloon pump (IABP) in advanced heart failure (HF) and cardiogenic shock (CS) is still under debate. In this study we sought to assess the clinical and hemodynamic outcomes in IABP-treated heart transplantation (HTx) patients as well as its impact on mortality. We retrospectively analyzed patients with advanced HF and CS, admitted in the cardiac intensive care unit (ICU) of our institution, between 2009 and 2020, who underwent HTx. We compared patients treated with IABP pre-HTx with a control (CR) group submitted to HTx without mechanical circulatory support. Propensity Score Matching was used to pair the groups according to relevant clinical covariates. 326 patients were included (IABP= 199; CR= 127). Overall survival was similar in IABP and CR groups at 30 days post-HTx (p=0.459). Clinical conditions improved 96 hours after IABP therapy. Central venous oxygen saturation (ScvO2) increased from 49.9% to 66.85% (p<0.001), and diuresis from 1690.12 mL/24 h to 2193.12 mL/24h (p<0.001). Lactate decreased from 21.91 mg/dl to 12.6 mg/dl (p<0.001) and creatinine from 2.04 mg/dL to 1.72 mg/dL (p=0.301). The use of nitroprusside increased from 58.08 to 63.59% (p=0.154), and norepinephrine decreased from 17.7% to 6.63% (p<0.001). The differences were maintained until HTx. IABP related complications were few. Overall outcomes of IABP in advanced HF and CS as a bridge therapy to HTx are encouraging. The survival rate was similar between the groups and IABP can be considered a safe and effective device with few and manageable complications.

Keywords

Intra-aortic Balloon Pump, Advanced Heart Failure, Cardiogenic Shock, Heart Transplantation

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1. Introduction

Cardiogenic shock (CS) is a clinical condition with a high mortality rate. Patients with severe ventricular dysfunction and advanced heart failure (HF) are often admitted to the intensive care unit (ICU) for hemodynamic support. Despite pharmacological treatment with diuretics, vasodilators and/or vasopressors and inotropes, many patients persist with shock signs and require advanced therapies as a bridge therapy to heart transplantation (HTx) [1].

Introduced in the 1960s, the intra-aortic balloon pump (IABP) is still a mechanical circulatory support device widely used in CS. Its hemodynamic benefits related to augmented cardiac output, improved coronary perfusion and reduced left ventricular afterload make it useful in the management of these patients [2].

Historically, most IABP studies are focused on CS related to acute myocardial infarction (AMI). Recently, observational studies with small groups of patients have shown conflicting results in assessing the influence of IABP on tissue perfusion in post-AMI cardiogenic shock [3]. One of the major question marks over the use of IABP was the publication in 2013 of IABP-Shock II, which evaluated 600 patients in CS after AMI and showed no significant difference in overall mortality between the IABP and control (CR) groups at 30 days [4]. These results led to changes in the recommendations of the American and European cardiology guidelines regarding the routine use of IABP in CS [5-8]. However, it should be noted that the indication of IABP is not restricted to AMI and the proposal to use it as a bridge therapy to HTx is a recent and growing perspective.

In the ICU of our institution, there is a significant number of critical patients waiting for HTx who are effectively transplanted, and the IABP continues to be one of the most widely used device in our setting for temporary support of these patients, mainly due to accessibility, technical ease of insertion at the bedside, and optimized costs for the national reality.

This study evaluates the effects of pre-HTx IABP on overall mortality 30 days post-HTx, as well as its efficacy and safety through its hemodynamic effects on target organ failure. Patients using IABP were compared with hemodynamically stable CR group undergoing HTx in the same period.

2. Methods

2.1. Study Design

This study is a single-center and retrospective analysis of patients who underwent HTx between 2009 and 2020 that were in the ICU before the surgical procedure. The patients included in the study were selected from the data records of the ICU of Heart Institute of the University of São Paulo, using electronic medical records.

The patients evaluated had a condition compatible with advanced HF and/or CS according to the criteria of the SCAI (society for cardiovascular angiography and interventions) shock classification [9], defined as: cold and clammy extremities, acute alteration of mental status, significant pulmonary congestion, cardiac index < 2.2 liters/min/m^2, pulmonary capillary pressure > 15 mmHg, rising lactate, 1.5-fold increase in baseline creatinine value or > 50% reduction in glomerular filtration rate, central venous saturation (ScVO2) < 65%, with the need for vasoactive drugs and/or devices to maintain blood pressure at adequate levels.

Patients who required mechanical circulatory support pre-HTx were selected for the IABP group. The CR group included patients who underwent HTx without the need for preoperative mechanical circulatory support. Patients with AMI were excluded from the sample.

Patients of the 2 groups, including their clinical and laboratory variables, were evaluated at the admission in the ICU, 24 hours before HTx, 2, 7 and 30 days after HTx. In the IABP group, clinical and laboratory variables were also assessed 6 to 12 hours before the IABP was inserted and 4 days afterwards (Figure 1).

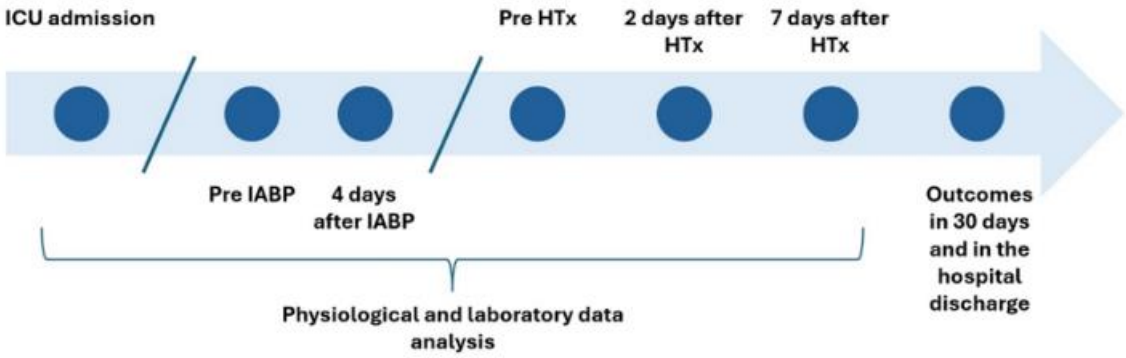

Figure 1. *Study design.*

2.2. Intra-Aortic Balloon Pump Therapy

IABP therapy was indicated when there was clinical deterioration and refractoriness to vasoactive drugs at optimized doses. Insertion was performed at bedside or with the aid of a fluoroscopy in the hemodynamic room, exclusively in the femoral artery.

2.3. Transplant Procedure

All patients underwent HTx according to the indication, protocol and specific list of Heart Institute of the University of São Paulo. Organ selection criteria and surgical technique were similar between patients. The same group of surgeons, assigned to the HTx team, were responsible for the surgeries. The use of IABP was maintained until the HTx was performed and in the immediate postoperative period.

2.4. Outcomes

The primary outcome evaluated was all-cause mortality at 30 days after HTx between the IABP and CR groups. Secondary outcomes included all-cause mortality after HTx in patients with Chagas Disease compared to other etiologies and assessment of the hemodynamic and renal response in patients who used pre-HTx IABP. The safety outcomes were bleeding, IABP-induced thrombocytopenia, infection and limb ischemia. They were classified as mild or severe when there was a need for transfusion, exchange or removal of the IABP.

2.5. Statistical Analysis

Continuous variables were compared using Student's t-test and categorical variables were compared using chi-square tests. Categorical variables are reported as frequency, and continuous variables are reported as mean ± standard deviation or median with interquartile range, as appropriate. Propensity Score Matching (PSM) was used to pair the groups according to relevant clinical covariates. Survival rates were calculated by the Kaplan-Meier method and compared by the log-rank test. For all comparisons, $p<0.05$ was considered significant. All analyses were performed using Stata 17 and IBM-SPSS for Windows version 22.0 and tabulated using Microsoft-Excel 2013.

3. Results

A total of 326 patients who underwent HTx between 2009 and 2020 were retrospectively evaluated, 199 of whom belonged to the IABP group and 127 to the CR group. The groups were homogeneous in terms of demographic, clinical and laboratory characteristics (Table 1). The mean age of the patients was 46.5 ± 12 years in the IABP group and 46.9 ± 14.4 years in the CR group (p=0.791) and there was a predominance of male patients (61.3% in the IABP group vs. 63% in the CR group, p=0.760). The mean Simplified Acute Physiology Score 3 (SAPS 3) on admission to the ICU was 36.8 ± 17.8% for the CR group and 32.6 ± 18.6% for the IABP group, with p=0.042.

Chagasic Cardiomyopathy was the most common etiology of HF in both groups (p=0.006), corresponding to 47.2% (n=94) of patients in the IABP group and 29.9% (n=38) of patients in the CR group, followed by Idiopathic Dilated Cardiomyopathy in 29.1% (n=58) of patients in the IABP group and 30.7% (n=39) of patients in the CR group, and Chronic Ischemic Cardiomyopathy in 12.1% (n=24) of patients in the IABP group and 18.1% (n=23) of patients in the CR group.

The mean left ventricular ejection fraction (LVEF) by transthoracic echocardiogram (TTE) was 23.5% ± 5.9 in the IABP group and 25.9% ± 9.5 in the CR group (p = 0.010). With regard to right ventricular (RV) dysfunction, 122 (37.4%) patients had moderate RV dysfunction, 75 (37.7%) patients in the IABP group and 47 (37%) patients in the CR group. Severe RV dysfunction was present in 51 patients (15.6%), with 32 (16.1%) patients in the IABP group and 19 (15%) patients in the CR group.

The primary outcome of mortality at 30 days after HTx occurred in 18.1% of patients in the IABP group and in 14.2% of patients in the CR group (p=0.354). Mortality on day 2, day 7 and day 15 occurred, respectively, in 4.5%, 8% and 12.6% of patients in the IABP group and 3.1%, 6.3% and 10.2% of patients in the CR group (p=0.537 2 days after HTx; p=0.557 7 days after HTx; p=0.523 15 days after HTx). Using PSM and the Kaplan-Meier method, there was also no difference in the survival rate between the IABP and CR groups at 30 days after HTx with p=0.4569 (Figure 2).

Table 1. *Demographic characteristics of the intra-aortic balloon pump and control groups.*

Variables	Group			
	Control (N = 127)	IABP (N = 199)	Total (N = 326)	p
Age (years), median ± DP	46.9 ± 14.4	46.5 ± 12	46.6 ± 13	0.791**
Gender (male), n (%)	80 (63)	122 (61.3)	202 (62)	0.76

Variables	Group			
	Control (N = 127)	IABP (N = 199)	Total (N = 326)	p
LVEF (%), median ± DP	25.9 ± 9.5	23.5 ± 5.9	24.5 ± 7.6	0.010**
Etiology, n (%)				0.006
Ischemic cardiomyopathy	23 (18.1)	24 (12.1)	47 (14.4)	
Chagasic cardiomyopathy	38 (29.9)	94 (47.2)	132 (40.5)	
Idiopathic cardiomyopathy	39 (30.7)	58 (29.1)	97 (29.8)	
Others	27 (21.3)	23 (11.6)	50 (15.3)	
Right ventricular dysfunction, n (%)				0.987
Normal	28 (22)	43 (21.6)	71 (21.8)	
Minor	33 (26)	49 (24.6)	82 (25.2)	
Moderate	47 (37)	75 (37.7)	122 (37.4)	
Severe	19 (15)	32 (16.1)	51 (15.6)	
Arterial Hypertension, n (%)	9 (7.1)	21 (10.6)	30 (9.2)	0.291
Diabetes Mellitus, n (%)	13 (10.2)	27 (13.6)	40 (12.3)	0.371
Chronic Kidney Disease, n (%)	20 (15.7)	44 (22.1)	64 (19.6)	0.158
Atrial Fibrillation, n (%)	33 (26)	56 (28.1)	89 (27.3)	0.67
Stroke, n (%)	18 (14.3)	29 (14.6)	47 (14.5)	0.943
Previous Acute Myocardial Infarction, n (%)	21 (16.5)	32 (16.1)	53 (16.3)	0.914
ICD, n (%)	33 (26)	41 (20.6)	74 (22.7)	0.258
SAPS 3 (%), mean ± DP	36.8 ± 17.8	32.6 ± 18.6	34.2 ± 18.4	0.042**
SAPS 3 (Total), mean ± DP	60.2 ± 10	57.4 ± 10.6	58.5 ± 10.4	0.018**
Post operative ICU stay (days), median (p25; p75)	9 (6; 15)	11 (7; 19)	10 (6; 17.3)	0.063£
Time from transplant to discharge (days), median (p25; p75)	35 (22; 48)	35 (24; 58)	35 (23; 52)	0.175£
IABP time (days), median (p25; p75)		20 (10; 33)	20 (10; 33)	&
ICU Discharge, n (%)	105 (82.7)	153 (76.9)	258 (79.1)	0.209
Discharge status, n (%)				0.138
Hospital Discharge	104 (81.9)	149 (74.9)	253 (77.6)	
Death	23 (18.1)	50 (25.1)	73 (22.4)	
Time of IABP ≥ 30 days, n (%)		104 (52.3)	104 (52.3)	&
Complications, n (%)		62 (31.1)	62 (31.1)	&
Bleeding, n (%)		13 (6.5)	13 (6.5)	&
Thrombocytopenia, n (%)		25 (12.6)	25 (12.6)	&
Infection, n (%)		19 (9.5)	19 (9.5)	&
Limb ischemia, n (%)		5 (2.5)	5 (2.5)	&

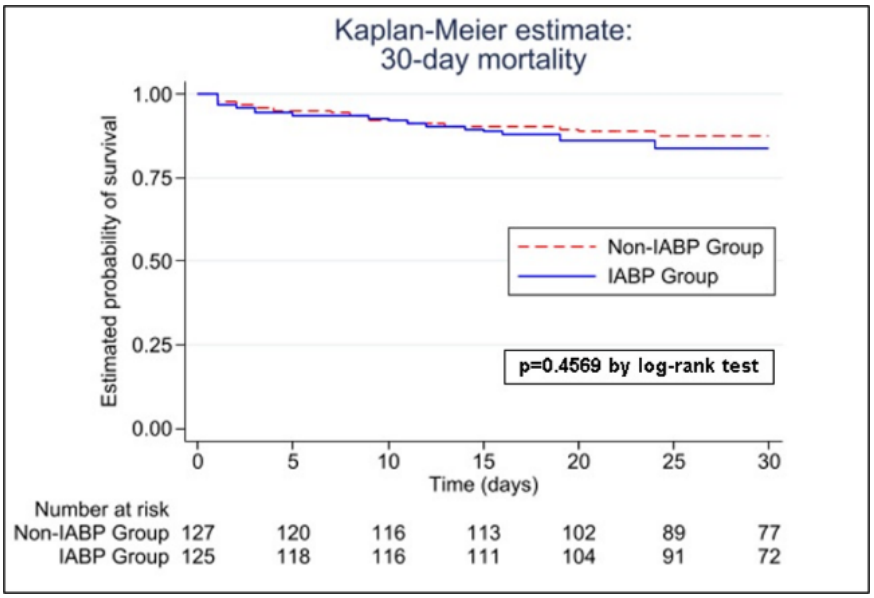

Figure 2. *30-day survival rate between IABP and control groups.*

In the secondary outcomes of mortality by etiology, it was observed that when the IABP and CR groups were evaluated together, there was no significant difference in the survival rate between Chagasic Cardiomyopathy compared to the other etiologies, with p=0.768. There was also no significant difference in the survival rate between etiologies only in patients from the IABP group (p=0.221), or only in patients from the CR group (p=0.421).

The 199 patients in the IABP group before HTx and their hemodynamic and renal response to mechanical circulatory support were retrospectively evaluated. The median time from IABP insertion to HTx was 20 days. Before the IABP, 193 (97.47%) patients were using dobutamine, 38 (19.29%) were using milrinone, 34 (17.17%) were using norepinephrine and 115 (58.08%) were using sodium nitroprusside.

Clinical and laboratory data were analyzed at the time of admission to the ICU (T1), 6 to 12 hours before IABP placement (T2), 96 hours after its insertion (T3) and 24 hours before HTx (T4). A comparison was made between T1xT4 and T2xT3 (Table 2). The mean ScvO2 on admission to the ICU, pre-IABP, post-IABP and pre-HTx was 65.6%, 49.99%, 66.85% and 63.22%, respectively (T1xT4 - p=0.691; T2xT3 - p<0.001). The mean lactate levels on admission to the ICU, pre-IABP, post-IABP and pre-HTx were 16.61 mg/dl, 21.91 mg/dl, 12.60 mg/dl and 11.95 mg/dl, respectively (T1xT4 - p<0.001; T2xT3 - p<0.001). The mean creatinine at admission to the ICU, pre-IABP, post-IABP and pre-HTx was 1.75 mg/dl, 2.04 mg/dl, 1.72 mg/dl and 1.33 mg/dl, respectively (T1xT4 - p<0.001; T2xT3 - p=0.301). The mean urea at admission to the ICU, pre-IABP, post-IABP and pre-HTx was 76.42 mg/dl, 67.33 mg/dl, 57.26 mg/dl, 52.98 mg/dl, respectively (T1xT4 - p<0.001; T2xT3 - p<0.001). The mean diuresis on admission to the ICU, pre-IABP, post-IABP and pre-HTx was 1740.35 ml, 1690.12 ml, 2193.7 ml, 2266.24 ml, respectively (T1xT4 - p<0.001; T2xT3 - p<0.001) (Table 3).

Four days after the IABP was introduced, all the patients who were using dobutamine had maintained its use (97.47%, p=0.323), 44 patients were using Milrinone (22.45%, p=0.234), 13 patients were using Norepinephrine (6.63%, p<0.001), a statistically significant reduction, and 124 patients were taking sodium nitroprusside (63.59%, p=0.154) (Table 4).

Long-term use of IABP was defined as use for more than 30 days. The mean time of uncomplicated IABP use until HTx was 23 ± 19.1 days and the maximum time of use was 107 days. Of 199 patients, 62 had complications related to IABP. Mild bleeding occurred in 11 patients (5.5%) and severe bleeding in 2 patients (1.0%). Mild IABP-induced thrombocytopenia occurred in 21 patients (10.5%) and severe IABP-induced thrombocytopenia occurred in 4 patients (2.0%). Infection occurred in 19 (9.5%) patients. Limb ischemia only occurred in its severe form in 5 patients (2.5%). Only one patient developed an ischemic stroke during the exchange of an IABP, which was promptly treated by activating the stroke protocol, performing thrombolysis, and achieving recanalization without significant sequelae.

Patients who developed an infection related to the IABP had a statistically longer duration of device use (52.1 ± 22.1 days, mean ± DP) compared to patients without any complications (p < 0.001). Patients who experienced any complication also had a statistically longer duration of IABP use (33.6 ± 27 days, mean ± DP) compared to patients without complications (p = 0.025). No deaths were attributed to IABP complications (Table 3).

Table 2. Organ perfusion improvement pre and post IABP.

	T1 ICU admission	T2 Pre-IABP	T3 Post-IABP	T4 Pre-HTx	T2xT3 p	T1xT4 p
Creatinine (mg/dL)	1.75	2.04	1.72	1.33	0.301	<0.001
Urea (mg/dL)	76.42	67.33	57.26	52.98	<0.001	<0.001
ScVO2 (%)	65.6	49.99	66.85	63.22	<0.001	0.691
Diuresis (ml/24h)	1740.35	1690.12	2193.7	2266.34	<0.001	<0.001
Lactate (mg/dL)	16.61	21.91	12.6	11.95	<0.001	<0.001

Table 3. Complications related to IABP.

Complications	IABP Time (days) mean ± SD	N median (p25; p75)	p	
Without complications	23 ± 19.1	19 (9; 29)	137	
Bleeding	36.1 ± 33.9	20 (11; 69)	13	0.328
Thrombocytopenia	23.1 ± 22.4	19 (8; 32)	25	0.733
Infection	52.1 ± 22.1	52 (41; 60)	19	<0.001
Ischemia	27.2 ± 35.2	7 (4.5; 60)	5	0.651
Any complications	33.6 ± 27	28 (11; 52.5)	62	0.025

Table 4. Vasoactive drugs pre and post IABP.

Vasoactive Drugs	T1 Pre-IABP	T2 Post-IABP	p
Dobutamine	193 (97.47%)	193 (97.47%)	0.323
Milrinone	38 (19.29%)	44 (22.45%)	0.234
Norepinephrine	34 (17.17%)	13 (6.63%)	<0.001
Sodium Nitroprusside	115 (58.08%)	124 (63.59%)	0.154

4. Discussion

In this study, we conducted a comprehensive analysis of IABP use in patients with advanced HF and CS. We evaluated the impact of pre-HTx IABP on post-HTx survival according to demographic, clinical and hemodynamic parameters and described the clinical and hemodynamic response to IABP in this population. Our main findings are: (1) The 30-day post-HTx survival rate was similar in the IABP and CR groups; (2) In patients undergoing HTx while on IABP, improvements were observed in macro- and micro-hemodynamic parameters and renal function after device placement; and (3) The IABP is a valuable tool as a bridge therapy to HTx in patients with advanced HF and CS, with low complication rates. In recent years there have been advances in the development of short- and long-term mechanical circulatory assistance devices, but CS is an entity that still has high mortality rates (30% to 50%) [10]. Most studies on CS have focused in patients after AMI,

showing no benefit in short- or long-term mortality [4]. Despite this, the findings of the CardShock study suggest that patients with CS of non-ischemic etiology have a better prognosis [11, 12] Although there is still a scarcity of prospective randomized studies in patients with advanced HF and CS out the context of AMI, our data demonstrate that IABP can be an effective device as a bridge therapy to HTx.

CS is a condition with a spectrum of varying degrees of clinical presentation and severity. IABP may not be sufficient to stabilize patients in CS post-AMI, but it may be beneficial in patients with advanced HF and CS who have previously adapted to a chronic state of low cardiac output. It is important to note that we included in our analysis patients with criteria for advanced HF and CS in both groups, with optimized pharmacological support with vasoactive drugs, awaiting HTx in the ICU. Patients with AMI-related CS were excluded from both groups.

Our study was retrospective, with a sizable sample of 326 patients, 199 in the IABP group and 127 in the CR group. The analysis showed that the population is well balanced, with no major clinical-demographic differences between the groups. The main etiologies of advanced HF and CS are Chagasic Cardiomyopathy followed by Idiopathic Dilated Cardiomyopathy, both in the CR group and in the IABP group. The incidence of the primary outcome of overall mortality 30 days after HTx was 18.1% in the IABP group and 14.2% in the CR group, and the Kaplan-Meier analysis showed a similar survival rate between the groups (p=0.4569), in line with previous studies [13, 14]. To obtain a non-biased estimate of the effect of IABP on mortality, we used PSM to balance the distribution of predictor variables between the groups and make them comparable.

We did not observe a difference in survival rate between the IABP and CR groups after HTx, but several factors can influence the outcomes of these patients, such as the etiology of HF, the duration of mechanical circulatory support device use, the time interval between device implantation and HTx, the complications inherent to the surgical procedure (pre- and post-operative), and post-HTx complications such as infection and rejection.

The ideal time for IABP implantation is essential to prevent hemodynamic worsening, significant renal dysfunction, progression to refractory CS and death. The hemodynamic response to the IABP observed in our study was comparable to the findings of previous reports with this device [15-18]. The use of the IABP promoted a significant reduction in the use of norepinephrine, a vasoconstrictor that increases left ventricular (LV) afterload and myocardial oxygen consumption in patients with advanced HF and CS. There was also an increase in the use of sodium nitroprusside, a potent arterial vasodilator known to be beneficial for patients with HF as it reduces LV filling pressures, systemic vascular resistance and LV afterload and consequently improves systolic volume and cardiac output. The hemodynamic improvement after IABP insertion was also accompanied by a concomitant decrease in serum lactate, creatinine and urea levels and a significant increase in $ScvO_2$ and diuresis after the device was inserted, which were maintained until HTx. We attribute this significant laboratory improvement to both the hemodynamic effects and the change in the use of vasoactive drugs associated with the use of IABP.

Both groups had similar clinical and laboratory conditions upon admission to the ICU. The mean levels of creatinine, $ScvO_2$ and lactate in the CR group at ICU admission are 1.6 mg/dl, 63.69% and 15.69 mg/dl, respectively, and in the IABP group, 1.75 mg/dl, 65.60% and 16.61mg/dl. While waiting for the HTx, the IABP group developed clinical and hemodynamic worsening, which led to progression to mechanical circulatory support. After 96 hours of insertion of the device, there was an improvement in clinical and hemodynamic parameters in the IABP group (Table 4), which remained until the moment of HTx, showing an equalization in the clinical condition between the groups. The day before HTx, the mean levels of creatinine, ScvO2 and lactate in the CR group are 1.23 mg/dl, 63.47% and 11.41 mg/dl, respectively, and in the IABP group, 1.33 mg/dl, 63.22% and 11.91mg/dl. The use of IABP in this population is well tolerated and successfully stabilizes patients with advanced HF and CS who are candidates for HTx and reinforces its role as an effective prolonged circulatory support in these patients.

In line with previous observations, our findings are consistent with a relatively low risk of IABP-related complications [11, 19, 20]. In fact, even long-term use of IABP has been shown to have low complication rates. Most of the complications related to IABP were mild. Major complications occurred in only 11 patients (5.5%). The main complication related to long-term use of the device was infection, which may be related to the long waiting time for HTx due to the current low number of donors, patients with extended hospitalization and poor nutritional status, with multiple invasions and more susceptible to infectious processes.

This study is subject to the limitations inherent in a retrospective observational analysis, including the potential for selection bias and other confounding variables. The outcomes reported by a single center may not be generalizable to all centers that perform HTx, given the differences in the clinical and demographic characteristics of the patients. Randomized clinical trials are considered the gold standard for evaluating the efficacy of treatments [21]. However, there are situations in which it is difficult to randomly allocate individuals between groups, as in the profile of the patients in this study, given their severity and need for progression of support to remain clinically stable and in adequate hemodynamic conditions until HTx. In this way, the use of PSM is extremely useful for balancing the distribution of variables between the groups and making them comparable, obtaining a non-biased estimate of the impact of the intervention on the outcome. In order to validate the similar results observed between the groups in our analysis, future studies on a larger scale will be important.

5. Conclusions

This study demonstrates that the IABP is a valuable tool as a bridge therapy to HTx in patients with advanced HF and CS, with a similar survival rate between the groups and an adequate hemodynamic and renal response in patients who required the device pre-HTx, with low complication rates.

Abbreviations

CS	Cardiogenic Shock
HF	Heart Failure
ICU	Intensive Care Unit
HTx	Heart Transplantation
IABP	Intra
AMI	Acute Myocardial Infarction
CR	Control
SCAI	Society for Cardiovascular Angiography and Interventions
ICD	Implantable Cardioverter
ScVO2	Central Venous Saturation
PSM	Propensity Score Matching
SAPS 3	Simplified Acute Physiology Score 3
LVEF	Left Ventricular Ejection Fraction
TTE	Transthoracic Echocardiogram
RV	Right Ventricular
LV	Left Ventricular

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Author Contributions

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Silvia Gelas Lage: Conceptualization, Formal Analysis, Investigation, Methodology, Project administration, Validation, Visualization, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Marcondes-Braga, F. G., Moura, L. A. Z., Issa, V. S., et al. Emerging Topics Update of the Brazilian Heart Failure Guideline - 2021. Arq Bras Cardiol. 2021 Jun 8; 116(6): 1174–1212. https://doi.org/10.36660/abc.20210367

[2] Kantrowitz, A., Tjonneland, S., Freed, P. S., et al. Initial clinical experience with intraaortic balloon pumping in cardiogenic shock. JAMA. 1968; 203(2), 113-118. http://doi.org/10.1001/jama.1968.03140020041011

[3] Prondzinsky, R., Unverzagt, S., Russ, M., et al. Hemodynamic effects of intra-aortic balloon counter pulsation in patients with acute myocardial infarction complicated by cardiogenic shock: the prospective, randomized IABP shock trial. Shock. 2012, 37(4), 378-384. http://doi.org/10.1097/SHK.0b013e31824a67af

[4] Thiele, H., Zeymer, U., Neumann, F. J., et al. Intra-aortic balloon counterpulsation in acute myocardial infarction complicated by cardiogenic shock (IABP- SHOCK II): final 12-month results of a randomized open-label trial. The Lancet. 2013, 382(9905), 1638-1645. http://doi.org/10.1016/S0140-6736(13)61783-3

[5] Hillis, L. D., Smith, P. K., Anderson, J. L., et al. 2011 ACCF/AHA Guideline for Coronary Artery Bypass Graft Surgery: Executive Summary: A Report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. Circulation. 2011, 124(23), 2610-2642. https://doi.org/10.1161/CIR.0b013e31823c074e

[6] Wijns, W., Kolh, P., Danchin, N., et al. Guidelines on myocardial revascularization: The Task Force on Myocardial Revascularization of the European Society of Cardiology (ESC) and the European Association for Cardio-Thoracic Surgery (EACTS). European Heart Journal. 2010, 31(20), 2501-2555. https://doi.org/10.1093/eurheartj/ehq277

[7] O'Gara, P. T., Kushner, F. G., Ascheim, D. D., et al. 2013 ACCF/AHA guideline for the management of ST-elevation myocardial infarction: executive summary: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines: developed in collaboration with the American College of Emergency Physicians and Society for Cardiovascular Angiography and Interventions. Catheterization & Cardiovascular Interventions. 2013, 82(1), E1-E27. https://doi.org/10.1002/ccd.24776

[8] Task Force on the management of ST-segment elevation acute myocardial infarction of the European Society of Cardiology (ESC), Steg, P. G., James, S. K., Atar, D., et al. ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation. European Heart Journal. 2012, 33(20), 2569-2619. http://doi.org/10.1093/eurheartj/ehs215

[9] Feldman, D., Pamboukian, S. V., Teuteberg, J. J., et al. The 2013 International Society for Heart and Lung Transplantation guidelines for mechanical circulatory support: executive summary. The Journal of Heart and Lung Transplantation. 2013, 32(2), 157-187. http://doi.org/10.1016/j.healun.2012.09.013

[10] Van Diepen, S., Katz, J. N., Albert, N. M., et al. Contemporary Management of Cardiogenic Shock: A Scientific Statement from the American Heart Association. Circulation. 2017, 136(16), e232-e268. http://doi.org/10.1161/CIR.0000000000000525

[11] Thiele, H., Zeymer, U., Neumann, F. J., et al. Intraaortic balloon support for myocardial infarction with cardiogenic shock. The New England Journal of Medicine. 2012, 367(14), 1287-1296. http://doi.org/10.1056/NEJMoa1208410

[12] Bertolino, N. D., Villafanha, D. F., Cardinalli-Neto, A., et al. Prognostic impact of Chagas' disease in patients awaiting heart transplantation. The Journal of Heart and Lung Transplantation. 2010; 29(4): 449-453. http://doi.org/10.1016/j.healun.2009.10.014

[13] Huckaby, L. V., Seese, L. M., Mathier, M. A., et al. Intra-aortic balloon pump bridging to heart transplantation. Circulation Heart Failure. 2020, 13(8), e006971. http://doi.org/10.1161/CIRCHEARTFAILURE.120.006971

[14] Gjesdal, O., Gude, E., Arora, S., et al. Intra-aortic balloon counterpulsation as a bridge to heart transplantation does not impair long-term survival. European Journal of Heart Failure. 2009; 11(7), 709-714. http://doi.org/10.1093/eurjhf/hfp078

[15] Bezerra, C. G., Adam, E. L., Baptista, M. L., et al. Terapia de Contrapulsação Aórtica em Pacientes com Insuficiência Cardíaca Avançada: Análise do Registro THE BRIDGE. Arquivos Brasileiros de Cardiologia. 2016, 106(1), 26-32. http://doi.org/10.5935/abc.20150147

[16] Baldetti, L., Pagnesi, M., Gramegna, M., et al. Intra-Aortic Balloon Pumping in Acute Decompensated Heart Failure with Hypoperfusion: From Pathophysiology to Clinical Practice. Circulation Heart Failure. 2021, 14(11), e008527. http://doi.org/10.1161/CIRCHEARTFAILURE.121.008527

[17] Den Uil, C. A., Van Mieghem, N. M., Bastos, M. B., et al. Primary intra-aortic balloon support versus inotropes for decompensated heart failure and low output: a randomized trial. EuroIntervention. 2019, 15(7), 586-593. http://doi.org/10.4244/EIJ-D-19-00254

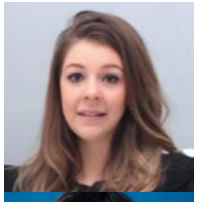
[18] Norkiene, I., Ringaitiene, D., Rucinskas, K., et al. Intra-aortic balloon counterpulsation in decompensated cardiomyopathy patients: bridge to transplantation or assist device. Interactive Cardiovascular Thoracic Surgery. 2007, 6(1), 66-70. http://doi.org/10.1510/icvts.2006.140160

[19] Ferguson, J. J. 3rd., Cohen, M., Freedman, R. J. Jr., et al. The current practice of intra-aortic balloon counterpulsation: results from the Benchmark Registry. Journal of the American College of Cardiology. 2001, 38(5), 1456-1462. http://doi.org/10.1016/s0735-1097(01)01553-4

[20] Koudoumas, D., Malliaras, K., Theodoropoulos, S., et al. Long-term intra-aortic balloon pump support as a bridge to left ventricular assist device implantation. Journal of Cardiac Surgery. 2016, 31(7), 467-471. http://doi.org/10.1111/jocs.12759

[21] D'Agostino, R. B. Jr. Propensity score methods for bias reduction in the comparison of a treatment to a non-randomized control group. Statistics in Medicine. 1998, 17(19), 2265-2281. http://doi.org/10.1002/(sici)1097-0258(19981015)17:19<2265::aid-sim918>3.0.co;2-b

Biography



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Research Field

Vanessa Sanches Corcioli Bellini: Cardiogenic shock, advanced heart failure, and mechanical circulatory support
Daniel Fatori: Epidemiology, Psychiatry, Randomized clinical trial
Fernanda Goncalves de Mateo Tamura: Cardiogenic shock, advanced heart failure, and mechanical circulatory support
Gabriel de Jesus da Fonseca Loureiro: Cardiogenic shock, advanced heart failure, and mechanical circulatory support
Milena Frota Macatrao-Costa: Cardiogenic shock and advanced heart failure, hypertrophic cardiomyopathy
Claudia Yanet San Martin de Bernoche: Cardiogenic shock, advanced heart failure, and mechanical circulatory support
Fabio Antonio Gaiotto: Advanced heart failure, heart transplantation, and mechanical circulatory support
Liliane Kopel: Cardiogenic shock, advanced heart failure, and mechanical circulatory support
Silvia Gelas Lage: Cardiogenic shock, advanced heart failure, and mechanical circulatory support