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ORIGINAL ARTICLE

Comparative Study Between Uses of Levosimendan Versus Intra-aortic Balloon Pump in High-risk Patients Undergoing Beating Heart Coronary Artery Bypass Surgery

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Abstract

Background: **Patients undergoing coronary artery bypass surgery (CABG), preoperative left ventricular insufficiency has been linked to increase mortality and morbidity. Intra-aortic balloon pump (IABP) helped high-risk cardiac patients during surgery to stabilize the hemodynamics. However, there are some drawbacks to balloon installation. Levosimendan, a newly developed medication, is now frequently utilized as an inotropic support without increasing the myocardium oxygen demand.**

Objective: **This study compared the effectiveness of levosimendan against IABP in candidates having beating heart CABG and who had reduced left ventricular function and ejection fraction below 35%t.**

Subjects and methods: **A prospective randomized clinical trial whereas 50 patients undergoing elective multivessel beating heart CABG shared and equally distributed to two groups, each includes 25 patients. The first is called levosimendan group, the second called IABP group. The hemodynamics, the biochemical markers, postsurgical ICU admission data and in-hospital fatality were also compared between these two groups.**

Results: **In comparison to the IABP group, the levosemindan group shows decreased ICU stay and in-hospital stay while maintaining similar hemodynamic functions, mechanical ventilation times and death rates.**

Conclusion: **In comparison to IABP, levosimendan infusion is a wise decision and a respectable alternative. Levosimendan use is comparable to IABP and decreases ICU and hospital stays for high-risk cardiac patients, when it comes to enhancing hemodynamics during and after beating heart CABG.**

Keywords: CABG, Intra-aortic balloon pump, Left ventricular dysfunction, Levosmindan

1. Introduction

With 31% of all recorded fatalities being caused by cardiovascular syndrome, it is the prominent cause of dying globally and is predicted to hold this position through the year 2030. The most prevalent of them is coronary heart disorder, also known as coronary artery disorder, which is the main reason of decease in industrialized nations.[1]

The calcium sensitizer levosimendan, which is the active enantiomer of simendan, was created for the curing of decompensating cardiac disaster, levosimendan promotes myocardial contraction without raising the cardiac oxygen demand, and its principal effects are independent to interactions with adrenergic receptors. Levosimendan is thought to be superior to beta-adrenergic medications due to its modest effects on heart rate, efficacy in patients

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taking beta-blockers and combination inotropic and vasodilation (inodilator) effect.[2]

Candidates having heart procedure are aging and developing more co-morbid conditions, increasing their risk of perioperative complications that increase mortality and raise the cost of the medical treatment.[3]

The majority of currently obtainable inotropic drugs has negative side-effects or has a poor safety profile, putting the diseased person at risk for complications and dangers associated with their therapy. To improve the results of cardiac surgery, one essential prerequisite is the prevention and effective treatment of low cardiac output syndrome.[4]

The intra-aortic balloon pump (IABP) consists of a vascular catheter with a balloon mounted at its distal end. The balloon is inserted through a retrograde puncture of the femoral artery and its distal tip should be positioned in the descending thoracic aorta immediately after the emergence of the left subclavian artery. The tip of the catheter coincides with the pulmonary carina and should be confirmed by chest x-ray. In its adequate positioning, the helium-inflated balloon is synchronized with the cardiac cycle: inflated during diastole and deflated during systole, resulting in increased coronary and systemic flow during the diastolic peak (inflated IABP), reduction of the after-load and the myocardial oxygen consumption (vacuum effect), coinciding with the rapid de-insufflation of the IABP at the beginning of systole.[5]

The current research equated the effects of Levosimendan versus IABP support on cardiac troponin I (cTnI) grades, hemodynamic enhancements, shorter stays in the ICU, reduced postoperative mechanical ventilation durations and hospital death rates in surgical Heart participants with reduced left ventricular ejection fraction (LVEF).

2. Subjects and methods

This research was conducted between November 2019 and January 2022, on 50 diseased persons with multivessel coronary artery disease suffering from Left ventricle ejection fraction (EF) less than or equal to 35% and ASA physical prominence III–IV undergoing beating heart CABG, attending to AlAzhar University Hospitals, Air Forces Specialized Hospital and AlAssema Hospital.

2.1. Inclusion data

Patients between 43 and 69 years of age.
Both gender male and female with no preferences.
BMI range from 18.5 to 35 kg/m^2.

2.2. Exclusion criteria

Age older than 70 years.
BMI less than 18.5 kg/m^2 or more than 35 kg/m^2.
Preoperative LVEF more than 35%.
Preoperative single vessel disease in coronary angiography.
Abnormal cardiac rhythm or Pacemaker dependant.
Intractable pulmonary oedema or the need for preoperative mechanical ventilation preoperative or severe hemodynamic unstability.
Previous cardiac surgery.
Neurological dysfunction which severely affecting ambulation or day to day functioning.
Chronic kidney disease with impaired renal functions.
Chronic liver impairment.
Any morphological valvular lesions which needs valve repair or replacement.

2.3. Methods

In all cases, history taking and physical examination, as well as complete laboratory investigation, chest x-ray, echocardiography and myocardial viability study (if available) were reviewed.

EF %, end diastolic diameter (EDD) and pulmonary artery systolic pressure (PASP) were estimated using Simpson's method by two-dimensional transthoracic echocardiography preoperative and 48 h postoperative.

Methods randomization: the randomization of patients was using a computerized program (SPSS), while sealed envelopes was numbered according to the randomization tables, than Packing, sealing and numbering of the envelope was performed by a neutral medical personnel (Under the supervision of doctors from the Department), the number of cases included in this study was simple randomly allocated into two groups.

Patients in levosimendan group; levosimendan infusion was started 12–24 h before operation with an initial dose of 12 μg/kg over 10 min, followed by 0.1 μg/kg/min over 24 h. Patients in IABP group; according to Santarpino et al.[6] the IABP was inserted through femoral artery using catheters 8.0 Fr 40 ml which then attached to the IABP machine intraoperative during cardiac manupilation and hemodynamic unstability. There was no significant difference in demographic data between the two groups regarding age, sex, BMI or clinical data.

All surgeries were performed using a standardized anaesthetic technique. Patients received premedication 3 mg Bromazepam (Calmepam) on the evening and the morning 2 h before the surgery.

In the operating theatre routine monitoring for coronary artery bypass surgery (electrocardiogram, SpO_2, IBP, capnogram and temperature) is applied to all patients.

The anaesthesia induction was provided by: Intravenous (IV) Midazolam 0.05 mg/kg, intravenous anaesthetic thiopental 3 mg/kg IV, Fentanyl 10 μg/kg IV slowly and rocuronium 0.6 mg/kg with intra-operative booster dose according to patients need.

After tracheal intubation, the patients were mechanically ventilated to maintain normocapnia with end tidal carbon dioxide ($ETCO_2$) 30–35 mm Hg and the anaesthesia is maintained by inhalational anaesthesia Sevofluran with 2% and rocuronium 0.15 mg/kg every 20 min.

To maintain an activated clotting time test more than 300 s during surgery, heparin at a dose of 200 Units/Kg loading dose, then 5–10 Units/kg/h was administrated intravenously. Other routine drugs were used as continuous infusion: Epinephrine, Norepinephrine, Dobutamine and Nitroglycerin regarding patient hemodynamics needs.

Anaesthetic management and surgical procedures were the same in both groups. Induction and maintenance of general anaesthesia was standardized in both groups. All procedures were performed using the beating heart CABG technique.

2.4. Information collection

Clinical and hemodynamic information collection:
Pulse rate (HR).
Arterial blood pressure (ABP).
Central venous pressure (CVP).
Oxygen saturation (SpO_2).
End tidal carbon dioxide ($ETCO_2$).

Arterial blood gas analysis: blood acidity (PH), partial pressure of oxygen (PaO2), partial pressure of carbon dioxide (PaCO2), bicarbonate (HCO3), serum sodium (NA), serum potassium (K).

Before induction, five minutes after anaesthetic induction, at the conclusion of operation and 6 h later at the time of ICU admission, hemodynamic data were recorded. The day before surgery and 48 h afterward, cardiac echography is performed to asses all of these parameters as: EF %, left ventricle end systolic diameter, left ventricle end diastolic diameter and pulmonary artery pressure.

2.5. Biochemical information collection

Each patient had tests done before the surgery by one day and 2 days postoperatively on their cTnI, total serum calcium, magnesium and potassium.

Arterial blood gas analysis.

ICU length of stay, postoperative mechanical ventilation duration, hospital total length of stay and mortality rate are also obtained.

Ethical aspect: Current study was performed after informed consent obtained from each patient as well as approval from our department council and local ethical committees of Azhar University Hospitals. Regarding other centres in the private hospitals informed consent from each patient has been obtained with respect of each hospital quality departments policies and procedures protocols.

2.6. Statistical analysis

IBM SPSS statistics (Statistical Package for Social Sciences) software version 23.0, IBM Corp., 2013 and Microsoft Office Excel 2007. Computer program was designed for accounting the sample size, the statistical calculator based on 95% of CI and the power of the study with α-error 5. The level of significance was taken at P value less than 0.050 is significant, otherwise is non-significant. The independent-samples t-test of significance was utilized, and the Mann–Whitney U test was used to compare two groups of non-parametric data. When the anticipated count in any cell was less than 5, the Fisher's exact test and the χ^2 test were used to compare groups with qualitative data.

Sample size justification:MedCalc® version 12.3.0.0 program 'Ostend, Belgium' was used for calculations of sample size, statistical calculator based on 95% confidence interval and power of the study 80% with α error 5%, According to a previous study Omar et al.[7] showed that the mean change of ejection fraction was 2.00 ± 4.20 for group A compared to 5.70 ± 4.90 for group B, with mean diff. 3.70; So it can be relied upon in this study, based on this assumption, sample size was calculated according to these values produced a minimal samples size 48 cases were enough to find such a difference, but the number will be increased to 50 to show appropriate results, will be equal to 25 patients per group.

2.7. Outcomes

Primary outcome: comparison of levosimendan versus IABP support regarding decrease in cTnI and in improvement of hemodynamics.

Secondary outcome: compare length of hospital stay, duration of postoperative mechanical ventilation and hospital mortality.

3. Results

Table 1.

Table 2 demonstrates notable statistical variation in EF% levels among both collections with *P* value ($P < 0.001$); also highly statistical significance mean value in EDD in Levosimendan collection comparing with IABP collection with *P* value ($P < 0.001$); while PASP insignificant difference with *P* value ($P > 0.05$) Table 3.

No noted variations among the studied candidates regarding to biochemical monitoring Table 4.

Statistical significance elevation mean value of K in IABP collection comparing with levosimendan collection, with *P* value less than 0.001; while the rest of parameters insignificant difference with *P* value greater than 0.05 Table 5.

No remarkable variations among the studied candidates related to HR, mean arterial pressure (MAP), Spo2, CVP and $ETCO_2$ whereas ($P > 0.05$) Table 6.

There were statistical significance elevation in mean level of K in IABP collection comparing with Levosimendan collection, with *P* value less than 0.001; while the rest of parameters insignificant difference with *P* value greater than 0.05 Table 7.

No remarkable variations among the studied candidates regarding to ICU data collection '6 h after surgery ends', with *P* value greater than 0.05 Table 8.

There were statistical significance higher mean value of ICU length of stay 'days' in IABP collection comparing to levosimendan collection, whereas *P* value ($P < 0.001$); also statistically significance

Table 1. Echocardiogram preoperative in both groups.

Echocardiogram preoperative	Levosimendan group ($n = 25$)	IABP group ($n = 25$)	*t*-test	*p* value
EF%				
Mean ± SD	29.95 ± 4.49	30.30 ± 3.40	−0.278	0.783
EDD (cm)				
Mean ± SD	6.49 ± 0.50	6.42 ± 0.41	0.521	0.606
PASP (mmHg)				
Mean ± SD	28.90 ± 6.97	28.30 ± 6.66	0.278	0.782

Using: t = independent sample *t*-test; *P* value > 0.05 NS.
There were no significances different between two groups regarding echocardiogram.
EDDend diastolic diameter; EF, ejection fraction; IABP, intra-aortic balloon pump; PASP, pulmonary artery systolic pressure.

Table 2. Echocardiogram 48 h postoperatively in both groups.

Echocardiogram 48 h postoperative	Levosimendan group ($n = 25$)	IABP group ($n = 25$)	Test value	*P* value
EF%				
Mean ± SD	34.28 ± 6.99	41.32 ± 6.30	t:−3.740	<0.001
EDD (cm)				
Mean ± SD	6.31 ± 0.45	5.73 ± 0.54	t:4.117	<0.001
PASP (mm Hg)				
Mean ± SD	24.76 ± 6.97	23.92 ± 3.26	U:0.546	0.588

EDD, end diastolic diameter; EF, ejection fraction; IABP, intra-aortic balloon pump; PASP, pulmonary artery systolic pressure.

Table 3. Comparing of the levosimendan and IABP collections based on biochemical monitoring.

Biochemical monitoring	Levosimendan group ($n = 25$)	IABP group ($n = 25$)	Test value	*P* value
Serum Ca preoperative (mg/dl)				
Mean ± SD	9.32 ± 0.60	9.01 ± 0.50	t:1.953	0.057
Serum Ca 48 h post (mg/dl)				
Mean ± SD	9.00 ± 0.64	8.83 ± 0.63	t:0.946	0.349
Serum Mg preoperative (mg/dl)				
Mean ± SD	1.96 ± 0.18	2.01 ± 0.09	t:−1.314	0.195
Serum Mg 48 h post (mg/dl)				
Mean ± SD	1.89 ± 0.15	1.79 ± 0.22	t:1.813	0.076
cTnI preoperative (ng/ml)				
Mean ± SD	0.28 ± 0.06	0.50 ± 1.15	U:−0.993	0.326
cTnI 48 h (ng/ml)				
Mean ± SD	0.19 ± 0.13	0.25 ± 0.19	U:1.303	0.199

IABP, intra-aortic balloon pump; TnI, troponin I.

Table 4. Comparing of intraoperative information collection 'before induction' between the levosimendan collection and the IABP collection.

	Levosimendan group ($n = 25$)	IABP group ($n = 25$)	Test value	P value
HR (beat/min)				
Mean ± SD	81.32 ± 10.86	81.00 ± 7.51	*t*:0.121	0.904
MAP (mmHg)				
Mean ± SD	80.20 ± 7.38	77.20 ± 7.78	*t*:1.399	0.168
SpO_2%				
Mean ± SD	93.06 ± 2.61	92.24 ± 1.85	*t*:1.282	0.206
CVP (mm Hg)				
Mean ± SD	8.88 ± 4.63	9.08 ± 5.96	U:−0.133	0.895
$ETCO_2$ (mm Hg)				
Mean ± SD	39.72 ± 1.43	40.04 ± 1.21	*t*:−0.855	0.397
PH				
Mean ± SD	7.40 ± 0.03	7.42 ± 0.01	*t*:0.333	0.741
pCO_2 (mm Hg)				
Mean ± SD	41.08 ± 1.58	40.88 ± 0.44	*t*:0.610	0.545
pO_2 (mm Hg)				
Mean ± SD	67.96 ± 3.06	68.36 ± 3.11	*t*:−0.458	0.649
Na (mEq/l)				
Mean ± SD	136.52 ± 1.26	136.64 ± 0.81	*t*:−0.400	0.691
K (mEq/l)				
Mean ± SD	3.56 ± 0.37	4.10 ± 0.25	*t*:−6.076	<0.001**
HCO_3(mEq/l)				
Mean ± SD	26.64 ± 1.25	26.92 ± 0.86	*t*:−0.920	0.362

CVP, central venous pressure; ECO_2, end tidal carbon dioxide; HR, heart rate; IABP, intra-aortic balloon pump; MAP, mean arterial pressure.

Table 5. Comparing of the IABP and levosimendan groups based on intraoperative information assembly '5 min after anaesthesia start'.

	Levosimendan group ($n = 25$)	IABP group ($n = 25$)	Test value	P value
HR (beat/min)				
Mean ± SD	91.40 ± 10.08	93.28 ± 10.36	t:−0.650	0.519
MAP (mmHg)				
Mean ± SD	74.56 ± 7.23	72.04 ± 8.71	t:1.113	0.271
SpO_2%				
Mean ± SD	98.68 ± 0.56	98.36 ± 0.64	t:1.890	0.065
CVP (mmHg)				
Mean ± SD	3.48 ± 3.78	4.48 ± 5.36	U:−0.762	0.450
$ETCO_2$ (mmHg)				
Mean ± SD	34.44 ± 1.39	34.40 ± 1.38	t:0.102	0.919

CVP, central venous pressure; ECO_2, end tidal carbon dioxide; HR, heart rate; IABP, intra-aortic balloon pump; MAP, mean arterial pressure.

higher mean value in-hospital stay 'days' in IABP collection comparing to levosimendan collection with P value ($P = 0.002$); while mechanical ventilation per hours and fatality insignificant difference whereas P value ($P > 0.05$).

4. Discussion

Levosimendan and IABP groups' patients' ages in the current study were equivalent (56.96 ± 6.94 vs. 58.84 ± 7.58 years, respectively). Additionally No remarkable variations among the studied candidates related to the sex based differences.

These results were consistent with those of other worldwide trials, including those by De Hert *et al.*[8] Malliotakis et al.[9] and Mate et al.[10] investigated the impacts of levosimendan in diseased candidates undergoing heart procedure who had inadequate Lt ventricular performance and discovered that the levosimendan and the conventional groups did not differ in relations of age or sex (IABP).

The serum calcium, magnesium and cardiac troponin I levels in the present study's preoperative and 48-h postoperative periods, there were non-statistical significance variations among the two collections ($P > 0.05$). While IABP group had the highest K value (4.07 ± 0.26) in comparing with the levosimendan group (3.63 ± 0.37), and there were a significance statistical variation among the two groups ($P < 0.001$).

Table 6. Comparing of the levosimendan and IABP groups based on intraoperative information assembly 'after procedure ending'.

	Levosimendan group ($n = 25$)	IABP group ($n = 25$)	Test value	P value
HR (beat/min)				
Mean ± SD	86.68 ± 9.56	86.08 ± 6.78	t:0.256	0.799
MAP (mmHg)				
Mean ± SD	75.48 ± 4.65	76.16 ± 4.04	t:−0.552	0.583
SpO_2%				
Mean ± SD	98.56 ± 0.71	98.64 ± 0.70	t:−0.401	0.690
CVP (mmHg)				
Mean ± SD	7.80 ± 2.93	8.08 ± 1.80	U:−0.407	0.686
$ETCO_2$ (mmHg)				
Mean ± SD	34.00 ± 2.66	34.80 ± 3.62	t:−0.891	0.378
PH				
Mean ± SD	7.31 ± 0.02	7.29 ± 0.02	t:1.840	0.072
pCO_2 (mmHg)				
Mean ± SD	44.24 ± 1.69	44.20 ± 1.63	t:0.085	0.933
pO_2 (mmHg)				
Mean ± SD	265.16 ± 36.33	272.00 ± 12.08	t:−0.893	0.376
Na (mEq/l)				
Mean ± SD	137.28 ± 1.70	136.36 ± 1.96	t:1.777	0.082
K (mEq/l)				
Mean ± SD	2.96 ± 0.36	3.77 ± 0.23	t:−9.596	<0.001**
HCO_3 (mEq/l)				
Mean ± SD	21.68 ± 0.99	21.60 ± 0.96	t:0.291	0.773

CVP, central venous pressure; ECO_2, end tidal carbon dioxide; HR, heart rate; IABP, intra-aortic balloon pump; MAP, mean arterial pressure.

Table 7. Comparing of the levosimendan and IABP collections based on ICU data collection '6 h after surgery ends'.

	Levosimendan group ($n = 25$)	IABP group ($n = 25$)	t-test	P value
HR (beat/min)				
Mean ± SD	84.80 ± 1.78	84.96 ± 1.70	t:−0.326	0.746
MAP (mmHg)				
Mean ± SD	75.68 ± 1.77	76.12 ± 2.13	t:−0.794	0.431
SpO_2%				
Mean ± SD	98.20 ± 0.82	98.60 ± 0.76	t:−1.789	0.080
CVP (mmHg)				
Mean ± SD	12.64 ± 2.00	12.04 ± 1.31	t:1.257	0.215
$ETCO_2$ (mmHg)				
Mean ± SD	35.58 ± 1.30	36.02 ± 0.83	t:1.426	0.160

CVP, central venous pressure; ECO_2, end tidal carbon dioxide; HR, heart rate; IABP, intra-aortic balloon pump; MAP, mean arterial pressure.

Table 8. Comparing of the levosimendan and IABP collections based on ICU data collection.

ICU data collection	Levosimendan group ($n = 25$)	IABP group ($n = 25$)	Test value	P value
ICU length of stay (days)				
Mean ± SD	3.40 ± 0.91	4.76 ± 1.05	U:−4.882	<0.001
Hospital stay (days)				
Mean ± SD	6.48 ± 1.08	7.96 ± 1.99	t:−3.266	0.002
Mechanical ventilation (h)				
Mean ± SD	23.36 ± 29.22	31.96 ± 26.66	U:−1.087	0.282
Mortality, n (%)				
No	23 (92.0)	22 (88.0)	x2 = 0.222	0.637
Yes	2 (8.0)	3 (12.0)		

IABP, intra-aortic balloon pump.

In contrast with the present study, Tritapepe and colleagues,[11] found that patients whom received levosimendan had remarkably decreased post-operative troponin I levels ($P < 0.0001$) than those who got a placebo (in a double-blind, placebo-controlled study). Lomivorotov et al.[12] evaluated levosimendan with IABP in high-risk cardiac patients. They clarified, when compared to a preoperative IABP, administration of levosimendan during anaesthesia induction shares to a reduced heart Troponin I level and better hemodynamics in cardiac surgery patients.

The most recent research in contrary to Malliotakis et al.[9] and Alvarez et al.[13] researches, they came to the conclusion that levosimendan has a strong vasodilator and inotropic action. Furthermore, Gandham et al.[14] demonstrated that the conventional group's HR was significantly higher at nearly all postoperative time points $P < 0.05$. The fact that they were primarily contrasting dobutamine with levosimendan may be the cause of this discrepancy.

The IABP group had the highest K level at surgery's conclusion (3.72 ± 0.23) comparing to the Levosimendan collection (2.94 ± 0.31). The IABP group had the highest K value during their stay in the ICU (4.13 ± 0.18 vs. 3.67 ± 0.14), with a remarkable statistical variation among the double collections whereas ($P < 0.001$). With a P value of 0.05, there were non-statistical significance differences among the double collections for PH, pCo2, pO2, Na, or HCO3. The usage of levosimendan raises two main issues: hypokalemia and hypotension. Hypokalemia's fundamental mechanism is still a mystery. When a bolus is given, the vasodilation and increased diuresis that cause hypotension become more pronounced.

When comparing the Levosimendan group (3.35 ± 0.88 days), the IABP group's distance of staying in the ICU were prolonged (4.80 ± 0.95 days). In addition, the IABP group's hospital length of stay was longer (7.95 ± 1.88 days) than the Levosimendan group's (6.55 ± 1.05 days), with highly statistically significance variations among the two groups ($P < 0.01$). Levosimendan 24 g/kg infusion for 10 min prior to starting CABG was utilized in a trial by Tritapepe and coworkers 10, and it resulted to significant decreases in the amount of time needed for tracheal intubation and the interval of Intensive care unite staying ($P < 0.01$ in both collections).

Similar to this, Severi et al.[15] found that patients pretreated with levosimendan had shorter ICU stays than those who received prophylactic IABP. Compared to the candidates getting levosimendan, the candidates in the IABP group spent more time in the ICU (average 6.5 ± 0.1 days) than the latter collection (average 4.6 ± 0.2 days).

Additionally, the research of Allama et al.[16] revealed that the average Intensive care unite staying in the control collection was (7.3 ± 0.85) days, (5.2 ± 0.85) days in the IABP candidates and 4.4 ± 0.77 days in the levosimendan candidates, among the three collections, there were remarkably significance variation.

The mean Intensive care unite staying in the IABP group was (6.5 + 0.1) days comparing to the levosimendan group's (4.4 + 0.2 days), showing a remarkable significance variation ($P < 0.001$). This information was recently published by Mate et al.[10] Levosimendan collection patients were discharged from the hospital 10.2 days later than the IABP grouped patients, which is remarkably significance variation ($P < 0.001$).

In contrast to our investigation, Desai et al.[17] discovered that hospital stays and ICU stays were comparable in the double collections. Additionally, Kandasamy et al.[18] found no differences between hospital and ICU stays.

In the present research, the duration of mechanical ventilating seemed similar in the IABP and Levosimendan groups (29.15 ± 21.57 and 26.05 ± 19.71 h, respectfully), and there were no remarkably significance variance among the both collections ($P > 0.05$).

In the current investigation, no patient required re-exploration as a result of bleeding. In contrast to our findings, Allama et al.[16] found that the control IABP, and levosimendan groups, respectively, had one patient, three patients and two patients with reopening, But Statistically there were no difference among the double collections.

In the current study, the fatality rates for the groups receiving IABP and levosimendan were 10% and 5%, correspondingly, with no statistical significance alteration between them ($P > 0.05$).

Primary results of a randomised clinical research conducted by Omar et al.[19] in 279 successive diseased persons with Lt. Ventricle EF 35% facing CABG procedure, found no significance variation in death rate among candidates receiving 0.1 g/kg/min levosimendan for 24 h and whom delegated to an IABP, despite the reduced time to ICU admission in the levosimendan group (4.4 vs. 5.2 days; $P = 0.05$).

Khaled et al.[20] divided 60 patients facing heart surgical intervention for valve, coronary bypass, or aortic aneurysm reparation whom had a preoperative LVEF of 35% into two groups: those receiving levosimendan ($n = 30$) and those getting conservative inotropes and vasoactive medications ($n = 30$). Primarily, 6–12 g/kg of levosimendan was administered as a loading dosage. Although LVEF improved ($P = 0.002$ vs. control group) and other

haemodynamics variations dependable with levosimendan's known features occurred, there were no notably variations in death among the both collections (9 deaths versus 10).

Wang and his partners,[21] in a single-centre, randomised controlled research, assessed the outcomes of a 24-h levosimendan infusion (i.v. bolus of 6–12 g/kg, then 0.1 g/kg/min infusion) in 59 sick people with acute decompensated heart failure. At the first-month of follow-up, each group had one documented death and one re-admitted to the hospital (in the placebo group).

Consequently, the usage of levosimendan in high-risk heart diseased candidates was fairly similar to that of IABP, with associated financial inferences for healthcare.

Additionally, Stefanelli et al.[22] recently clarified the usage of IABP significantly decreased in diseased candidates with ischaemic congestive heart failure whom faced surgical rebuilding of left ventricle (primarily surgical myocardial re-vascularization and/or mitral valve repair) as a result of the acceptance of the continued infusion protocol of levosimendan and amiodarone (beginning with start of the surgical intervention). Only two of 24 diseased candidates (8%) whom got levosimendan needed an IABP implant, as opposed to 11 of 38 patients (29%) who did not ($P = 0.018$).

Lower heart risk explains cardiac safety. The positive impact of levosimendan on the equilibrium between the oxygen supply and demand in the myocardium may also have an impact on troponin I concentration. However, there were no differences in mortality or the prevalence of any serious problems among the two groups of our study. According to our assessment, the reduction in myocardial impairment throughout levosimendan administration may be advantageous and shorten hospital admission.

4.1. Conclusion

Levosimendan infusion is an excellent choice with an acceptable selection in comparison to IABP. Levosimendan is equivalent to IABP in progressing hemodynamic status before and after beating heart CABG and resulting minimized ICU and hospital admissions in high-risk cardiac patients.

Authorship

All authors have a substantial contribution to the article.

Conflicts of interest

There are no conflicts of interest.

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