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The Effect of Early Ambulation on Hemodynamic and Perfusion Indices Post Cardiac Surgery

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Abstract Delayed mobilization of cardiac surgical patients (CSPs) postoperatively is a huge challenge for critical care nurses (CCNs). Early ambulation (EA) is a vital task with a significant priority of nursing practice in critical care units (ICUs). CCNs' awareness of EA value for CSPs' outcomes is the main concern. The inclusive aim of EA is to sustain hemodynamic stability and adequate organ perfusion. The current study aimed to examine the effect of EA on hemodynamic and perfusion indices post cardiac surgery. Sixty adult patients of both sexes undergoing cardiac surgery were involved in this study. Then they assigned randomly into two groups; EA group and hospital care (HC) group. Data were collected using one tool which encompasses three parts containing the patient preoperative basic health data, hemodynamic indices record and perfusion indices record. The findings presented that peripheral pulse (PP) and heart rates were decreased tenuously among the EA patients compared with HC patients. However, the systolic blood pressure (SBP), diastolic blood pressure (DBP) and mean arterial pressure (MAP) were increased significantly in EA group than HC group post ambulation compared with preoperative readings. Additionally, perfusion indices were increased among the EA patients and HC patients post mobilization compared with preoperative readings. The current study showed that EA has better effect on the patients hemodynamic and perfusion indices postoperatively. Thus, CCNs should give a high priority to plan EA schedule when caring for CSPs. Furthermore, there is a need for EA algorithms in ICUs.

Keywords: *early ambulation, hemodynamic indices, perfusion indices, cardiac surgery, critical care nurse*

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1. Introduction

Cardiac surgical patients are usually more unstable than other surgical patients due to intraoperative and cardiac manipulation [1]. After surgery, patients are admitted to the cardiothoracic ICU with various tubes and lines. Bed rest is often an integral part of routine postoperative care for them. Because bed rest does not have any significant beneficial effect on those patients, this view is not supported by any evidence [2]. However, resuscitation and patients' survival are the main focus of CCNs with very little attention given to the muscular function [3]. Recently, CCNs recognized that the immobilized patient in ICU can suffer from physical function impairment and complicated recovery [4,5].

The respiratory and cardiovascular systems can be mainly affected by immobilization or bed rest [6]. Consequently, it can produce three major cardiovascular changes as orthostatic hypotension, raised cardiac workload [7], and thrombus formation due to compile of blood in lower extremities and declined the circulating volume [8]. Additionally, a dropping in venous return, central venous pressure, and arterial blood pressure are noted due to bed rest [9]. The resting heart rate also increased from 4 to 15 beats per minute with prolonged bed rest [6]. Thereby, the instability of CSPs' hemodynamic indices is the pioneer cause of extended bed rest periods [10].

Van-Laar, TImman & Noyez [11], noticed that the reduction of physical activity is an indicator for unsafe and hard recovery period following cardiac surgery. Fortunately, early activity for critically ill patients has vital advantages on all body systems; particularly on hemodynamic and perfusion parameters [12]. Thereby, EA in intensive care settings has been broadly progressing over the last decade [13]. It is a significant component of physiotherapy schedules for cardiac surgical patients that improve respiratory and cardiovascular functions. It can reduce the adverse effects of bed rest and immobility [14].

It has been noted that EA could not cause hemodynamic or perfusion instability for critically ill patients who have apparent cardiovascular insufficiency [15]. Moreover, recent studies and novel literature have focused on the applicability and safety of EA in ICUs [16,17]. According to [18], EA is an easy and broadly practicable nursing intervention for critically ill patients. It may be more efficient than other nursing interventions for lowering patients' morbidity and mortality rates.

Early ambulation has currently been advanced by CCN as a member of health care team as reported by [19]. Early ambulation following cardiac surgery in ICUs is recently an interesting and attractive field for nurses [20]. It is a recurrent pivotal nursing activity that often performed in critical care setting [10]. Thus, EA for CSPs is a significant integral part of CCNs tasks [21].

Hemodynamic indices are an entire part of diagnosis and management of critically ill patients. It provides fundamental data about the cardiovascular function and efficacy of treatment [22]. Additionally, it provides enrich reflecting data about the early circulatory system changes [23]. The main vital hemodynamic indices involve PP and heart rates, systolic, diastolic and mean arterial pressures [24]. Perfusion indices encompass central venous pressure (CVP), body temperature and capillary refill.

1.1. Significance of the Study

Delayed mobilization of CSPs postoperatively is a huge challenge for CCNs. In the setting of the current study, there are numerous reasons for this delay such as fear of dislodged tubes or catheters, patient's falling and limited resources for monitoring during ambulation. Lack of nursing awareness about the multiple beneficial effects of early ambulation for patients and resources is another significant issue. All these factors can lead to delay in patient's ambulation and prolong length of ICU stay post cardiac surgery. Broaden research on early mobilization for critically ill patients were carried out. The majority of them examined the effectiveness of EA on mechanically ventilated patients and other large surgeries but limited studies have evaluated its main effects on improving CSPs' hemodynamic and perfusion indices. However, the studies that investigated this area in Egypt are very limited considering the significance of this topic in relation to critical care nursing practice. Thus, this study was conducted to address this issue.

1.2. Aim of the Study

The current study aimed to examine the effect of early ambulation on hemodynamic and perfusion indices post cardiac surgery.

1.3. Research Hypothesis

Patients who are ambulated early after cardiac surgery will have better hemodynamic and perfusion indices than patients who are not.

2. Subjects and Methods

2.1. Research Design

A quasi experimental study was used to collect information regarding cardiac surgical patient's hemodynamic and perfusion indices pre and postoperatively in relation to patient's mobilization.

2.2. Research Subjects

A convenience sample of 60 adult patients of both sexes undergoing cardiac surgery was included in the study. Patients with cardiovascular respiratory functions stability were enrolled in the study. Patients were excluded from the study if receiving high inotrope titration after 4 hours of operation, having delayed ventilation weaning (more than 6 hours postoperatively) or on opiate sedation. Patients who have activity intolerance, liability of bleeding, fluid and electrolytes imbalance and/or fever were also excluded from the study.

The sample size was estimated by PASS software version 11. In previous study by [25], a significant improvement in all cardiovascular parameters was detected with early activity postoperatively including hospital stay (44.95±13.99 versus 122.49±50.99). Group sample sizes of 15 and 15 achieve 99% power to detect a difference of -77.5 between the null hypothesis that both group's means are 45.0 and the alternative hypothesis of group 2 is 122.5 with estimated group standard deviations of 14.0 and 51.0 and significance level (alpha) of 0.01000 using a two-sided two-sample t-test. Then the sample was assigned randomly into two groups: '30' patients as an EA group and '30' patients as HC group.

2.3. Setting

The research was conducted in Cardiothoracic Surgical ICU of Mansoura Main University Hospital. The unit contains 7 beds and each bed is equipped with the essential technologies required for monitoring and management. According to the unit records, during 2018, the patients flow was 6 cases per week. The nurse-patient ratio is 1:2.

2.4. Ethical Considerations

Ethical approval was gained from the Research Ethics Committee of Faculty of Nursing, Mansoura University. Further approval was granted from the manager of Mansoura Main University Hospital. An informed consent was obtained from the patient or the First Kin who accepted to participate in the study after giving them complete information about the nature of the study. The patients were doubtless that their participation in the study was voluntary and that they had the right to accept or refuse to take part in the study without any effect on their care or treatment. They were also assured that they can withdraw at any time from the study. Additionally, they were informed that their personal information would be kept confidential and they would not be identified.

2.5. Instrument

Data were collected using one tool "the early ambulation sheet for cardiac surgical patients" that was developed by the researcher based on the related recent literature [2,23,26-32]. It consisted of three parts. Part one is concerned with the patient's preoperative basic health data such as age, gender, occupation and type of surgery. Part two involved the hemodynamic indices record includes 5 main indicators as PP rate, heart rate, SBP, DBP, and MAP. The last part included the perfusion indices record that composed of 3 main indicators as CVP, body temperature and capillary refill. Content validity of the tool was examined by 7 experts from critical care

and emergency nursing department and cardiothoracic surgeons, Faculty of Medicine, Mansoura University. A pilot study was carried out on 6 patients to review the feasibility and applicability of the tool. Modifications were done accordingly. The pilot study participants were eliminated from the study sample.

2.6. Data Collection

Data were collected from January to April 2018. The patient's basic health data was obtained once preoperatively for both groups using part 1. The EA group was instructed and trained about the ambulation attempts and schedule preoperatively (Figure 1). The hemodynamic (part 2) and perfusion (part 3) indices were monitored and recorded as a base data preoperatively except CVP for both groups. According to the unit protocol, all patients were weaned and extubated within 6 hours postoperatively. After extubation, the EA patients were instructed to wear chest belt before initiating mobilization for supporting their wound. Then they encouraged performing ambulation attempts (Figure 1). However, the HC group received the routine hospital care. Postoperatively hemodynamic and perfusion indices were monitored pre and post each ambulation attempt for both groups on the day of surgery. Each ambulation attempt was taken from 5 to 10 minutes. The indices were recorded before any ambulation attempt while the patient was on supine position. Post ambulation attempt, the patient rested for 5 minutes then the hemodynamic and perfusion indices were monitored.

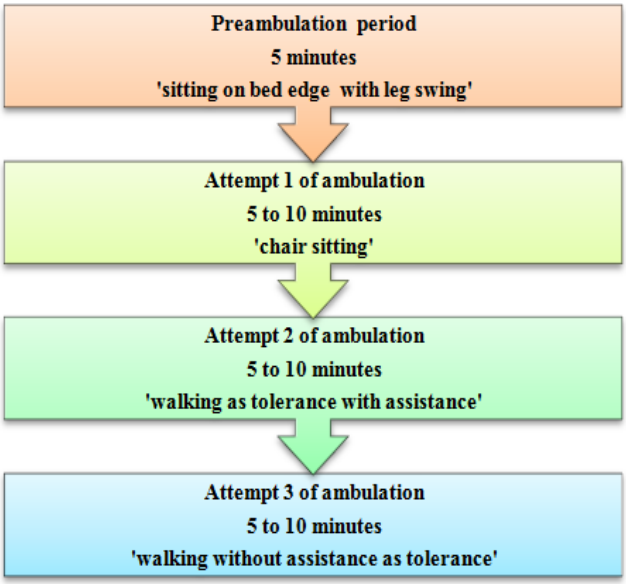

Figure 1. Flow chart of the ambulation attempts

2.7. Data Analysis

Data were entered and analyzed using the Statistical Packaged for Social Science (SPSS) software version 25.0. Nominal data were described by frequency and percent. Ordinal data were expressed as median and interquartile range (IQR). However, quantitative data were described as means and standard deviations. Qualitative data were compared by Chi-Square test. The statistical analysis was performed using two-tailed Student's t-test for independent variables that are normally distributed. But the non-parametric alternative Mann-Whitney U-test was used to compare quantitative data between two groups. Analysis of variance for repeated measurements was used and followed by Mauchly's test of sphericity (greenhouse-geisser/sphericity assumed) and pairwise Student's t-tests to adjustment for multiple comparisons. For any of the used tests, results were considered as statistically significant if p value ≤ 0.050. Appropriate charts were used to graphically present the results whenever needed.

3. Results

Table 1 depicts patient's basic health data. The median age value was almost 29 in both groups. More than half of studied patients were males in both groups (56.7% and 53.3% respectively). A considerable percent of EA group were employed (60%). The most common type of surgery in EA group was mitral valve and double valve replacement (30% for all) and mitral valve replacement for HC group (36.7%). The differences between both groups concerning the age, gender, occupation, and type of surgery were statistically not significant.

Table 1. Patient's basic health data

Basic health data	Early ambulation (n = 30)	Hospital care (n = 30)	Significance test	
			χ^2	*p*
Gender				
• Male	17 (56.7)	16 (53.3)	0.067	0.795
• Female	13 (43.3)	14 (46.7)		
Occupation				
• Employee	18 (60)	14 (46.7)	1.071	0.301
• Unemployed	12 (40)	16 (53.3)		
Type of surgery				
• MVR	9 (30)	11 (36.7)	1.99	0.782
• AVR	7 (23.3)	9 (30)		
• DVR	9 (30)	5 (16.7)		
• CABG	2 (6.7)	3 (10)		
• CR	3 (10)	2 (6.7)		
Age Median (IQR)	28.5 (21.8 - 37.3)	29 (22.8 - 41)	**z value** -0.326	0.745

Data are expressed as frequency (%) unless otherwise stated
MVR: Mitral Valve Replacement, AVR: Aortic Valve Replacement, CR: Congenital Repair, DVR: Double Valve Replacement, CABG: Coronary Artery Bypass Graft, z: Mann-Whitney, χ^2: Chi-square test, *p* is significant if ≤ 0.05.

Table 2 compares the EA group and the HC group regarding patient's preoperative hemodynamic and perfusion indices. The data revealed that no statistical significant difference was detected between the two groups in relation to PP and heart rates, SBP, DBP and MAP. On the same line, the findings showed no statistically significant difference between EA and HC groups regarding capillary refill. Most of EA patients (56.7%) had delayed capillary refill time, while the same percentage of HC patients was within normal time. On the contrary, the body temperature slightly rises in EA group (36.82±0.18) than the HC group (36.62±0.38) with statistical significant difference between both groups (p= 0.026).

Table 2. Comparison between early ambulation and hospital care groups as regards the preoperative indices

Preoperative indices	Early ambulation (n = 30)	Hospital care (n = 30)	Significance test	
			z value	*p*
Hemodynamic				
• PPR	70.13±11.91 (66.5)	74.37±10.76 (73)	-1.271	0.204
• HR	87.50±9.84 (89.5)	88.30±9.18 (90)	-0.267	0.790
• SBP	122.67±14.12 (120)	121.00±18.30 (120)	-0.678	0.498
• DBP	76.00±11.32 (75)	75.83±16.76 (70)	-0.365	0.715
• MBP	91.55±10.56 (88.3)	40.88±15.20 (68.3)	-0.573	0.567
Perfusion				
• Temp	36.82±0.18 (36.9)	36.62±0.38 (36.7)	-2.223	**0.026**
• Capillary refill: frequency (%)			χ^2	
- Normal	13 (43.3)	17 (56.7)	1.067	0.302
- Delayed	17 (56.7)	13 (43.3)		

Data are expressed as mean ± standard deviation (median) unless otherwise stated, PPR: Peripheral pulse rate, HR: Heart rate, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, MBP: Mean blood pressure, Temp: Body Temperature, χ^2: Chi-square test, SD: Standard Deviation, *p* is significant if ≤ 0.05

Table 3 highlights the main EA group effect regarding pre and postoperative hemodynamic and perfusion indices. The data showed significant increase in PP and heart rates over time throughout the ambulation Attempts with p value <0.0005 and 0.007 respectively. The pairwise comparison revealed significant difference between preoperative and post first and second attempts, and pre and post third attempt of ambulation. However, there was no statistical change in relation to SBP and MAP over time during the study. Conversely, DBP was significantly reduced over time with p value 0.003 and its pairwise comparison shows significant difference between preoperative and pre third attempt readings. Moreover, all perfusion indices in relation to CVP, body temperature and normal time of capillary refill imply a significant difference over time with p value <0.0005 for all indices. Regarding pairwise comparison, CVP showed statistically significant difference between pre first attempt and pre and post third attempt readings. Whereas, capillary refill was displayed statistically significant difference between preoperative and all readings of second and third attempts of ambulation. Otherwise, body temperature pairwise comparison implies statistically significance difference between preoperative and all attempts readings except the pre third attempt of ambulation.

Table 4 illustrates the HC group pre and postoperative hemodynamic and perfusion indices. The findings showed significant rise over time in relation to PP and heart rates with p value 0.001 for all. Pairwise comparison for PP and heart rates revealed a statistically significant difference between preoperative and all postoperative readings. On the contrary, there was a significant reduction over time in relation to SBP and DBP with statistically significant difference with DBP only (p=0.001). Thereby, pairwise comparison for SBP and DBP represents significant difference between preoperative and the pre third attempt. Nevertheless, data imply a marked increase regarding MAP over time during the study period with p=0.013, and its pairwise comparison shows significant difference between preoperative and the pre third attempt readings. As regards perfusion indices such as CVP, body temperature and capillary refill, the findings indicated statistically significant difference in all indices with p value <0.0005 for all indices. The pairwise comparison of CVP showed statistically significant difference only between first and third attempts readings. Otherwise, body temperature pairwise comparison implies statistically significance difference between preoperative and all postoperative readings. It was noted that capillary refill was delayed in most HC patients until the end of the study.

Table3. Main early ambulation group effect regarding pre and postoperative indices

Indices	Early ambulation group (n = 30)							Significance test		
	Preoperative	Attempt 1		Attempt 2		Attempt 3		F	*p*	η^2
		Pre	Post	Pre	Post	Pre	Post			
Hemodynamic										
• PPR	70.13±11.91	77.76±9.44	78.56 ±8.31	79.2±9.77	79.66 ±8.18	80.53 ±9.46	82.9 ±9.8	8.313	**<0.0005**	0.222
Pairwise	a	a, b	b	b	b	b	b			
• HR	87.5±9.84	92.8±12.43	96.53±12.25	95.1±13.66	95.56±12.72	95.7±9.27	97.5±11.56	3.525	**0.007**	0.108
Pairwise	a	a, b	a, b	a, b	a, b	a, b	b			
• SBP	122.66 ±14.12	123.0±12.01	128.5±17.86	122.83±15.18	120.66±15.12	121.5±14.68	122.5±14.66	1.419	0.229	0.046
• DBP	76.0±11.32	66.66 ±11.24	71.33±10.58	70.66±9.62	71.83±9.51	67.66±8.17	73.83±8.47	4.153	**0.003**	0.125
Pairwise	a	a, b	a, b	a, b	a, b	b	a			
• MBP	91.55 ±10.56	85.44±9.45	90.38±11.93	88.05±10.32	88.11±9.90	85.61±8.40	90.05±9.43	2.416	**0.054**	0.076
Perfusion										
• CVP	-	8.77±2.62	9.17±3.11	9.33±2.55	9.90±2.44	10.57±1.89	12.03±1.79	13.986	**<0.0005**	0.325
Pairwise	-	a	a, b	a, b	a, b	b	c			
• Temp	36.82 ±0.18	37.21±0.39	37.27±0.28	37.15±0.37	37.22±0.33	37.02±0.38	37.13±0.42	8.071	**<0.0005**	0.217
Pairwise	a	b, c	b	b, c	b, c	a, c	b, c			
• Capillary refill: frequency (%)										
- Normal	13 (43.3)	15(50)	17 (56.7)	23(76.6)	27(90)	28(93.3)	29(96.7)	52.585	**<0.0005**	-
- Delayed	17 (56.7)	15(50)	13 (43.3)	7(23.3)	3(10)	2(6.7)	1(3.3)			
Pairwise	a	a, c	a, c	b, c	b	b	b			

Data are expressed as mean ± standard deviation unless otherwise stated

Pairwise comparisons are presented as letters pairwise with deferent letters have a statistical significant difference and pairwise with similar letters have non statistical significant difference.

F value: Mauchly's Test of Sphericity(Greenhouse Geisser/Sphericity Assumed), η^2: Partial Eta Squared, χ^2: Chi-square test, SD: Standard Deviation, PPR: Peripheral pulse rate, HR: Heart rate, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, MBP: Mean blood pressure, Temp: Body Temperature, CVP: Central Venous Pressure *p* is significant if ≤ 0.05.

Hemodynamic indices of early ambulation and hospital care groups are illustrated in Figure 2 regarding PP and heart rates, SBP, DBP and MAP pre and postoperatively. It is clear that PP and HR rates were decreased tenuously among the EA patients compared with HC patients. Otherwise, SBP, DBP and MAP were increased significantly in EA group than HC group post ambulation compared with preoperative readings.

Figure 3 represents perfusion indices of EA and HC groups regarding body temperature and CVP readings pre and postoperatively. It showed that both indices were increased among the EA patients and HC patients post mobilization compared with preoperative readings. However, CVP and body temperature were trivially increased in EA group compared with HC group.

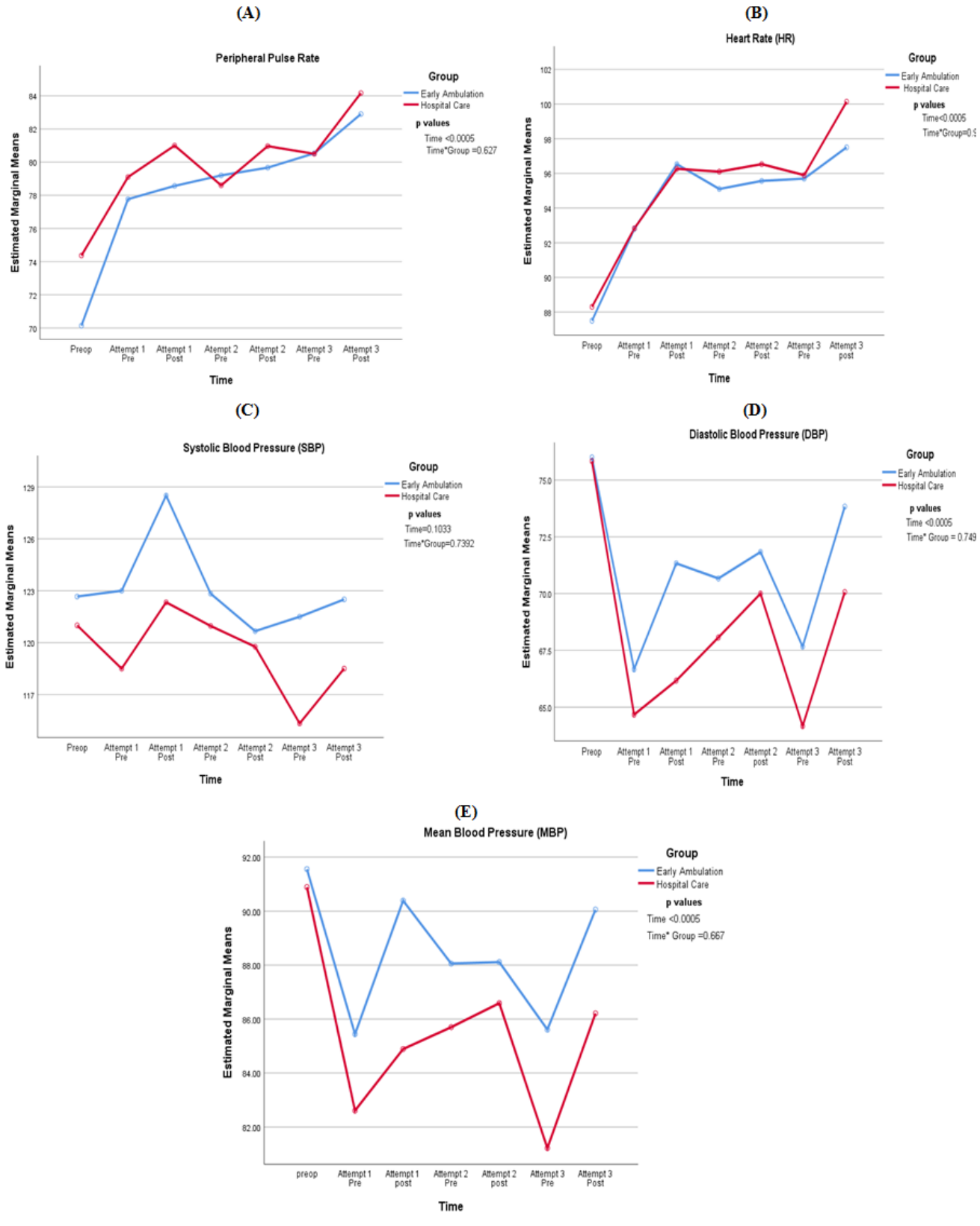

Figure2. Comparison between pre and postoperative hemodynamic indices among groups

Table 4. Hospital care group pre and postoperative hemodynamic and perfusion indices

Indices	Hospital care group (n = 30)							Significance test		η^2
	Preoperative	Attempt 1		Attempt 2		Attempt 3		F	*P*	
		Pre	Post	Pre	Post	Pre	Post			
Hemodynamic (Mean ± SD)										
• PPR	74.36±10.76	79.1±8.02	81.0±10.97	78.6±10.53	80.96±10.68	80.5±9.65	84.16±11.92	4.826	**0.001**	0.142
Pairwise	a	a, b	a, b	a, b	a, b	a, b	b			
• HR	88.3±9.18	92.83±11.67	96.26±12.53	96.1±12.49	96.53±12.54	95.9±8.12	100.13±10.96	5.120	**0.001**	0.150
Pairwise	a	a, b	a, b	a, b	a, b	a, b	b			
• SBP	121±18.31	118.5±9.75	122.33±15.68	120.96±12.62	119.76±12.91	115.33±11.44	118.5±11.31	1.049	0.379	0.034
Pairwise	a, b, c	a, b, c	b	a, b, c	a, b, c	c	a, b, c			
• DBP	75.83±16.76	64.66±7.97	66.16±9.16	68.06±5.69	70.0±8.71	64.16±6.02	70.06±10.89	5.500	**0.001**	0.159
Pairwise	a	b, c	a, b, c	a, b	a, b, c	c	a, b, c			
• MBP	40.88±15.20	82.61±6.31	84.88±10.01	85.70±6.64	86.58±8.43	81.22±6.79	86.21±9.25	3.759	**0.013**	0.114
Pairwise	a	a, b	a, b	a	a, b	b	a, b			
Perfusion										
• CVP	-	8.50±2.56	8.80±2.61	9.50±2.79	9.70±3.24	11.00±2.85	12.33±2.80	17.684	**<0.0005**	0.379
Pairwise	-	a	a	a, b	a, b	b	c			
• Temp	36.62±0.38	37.06±0.35	37.14±0.38	37.11±0.37	37.13±0.37	36.99±0.447	37.07±0.44	7.334	**<0.0005**	0.201
Pairwise	a	b	b	b	b	b	b			
Capillary refill: frequency (%)										
- Normal	17 (56.7)	2(6.7)	4(13.3)	9(30)	13(43.3)	21(70)	22(73.3)	67.795	**<0.0005**	-
- Delay	13 (43.3)	28(93.3)	26(86.7)	21(70)	17 (56.7)	9(30)	8(26.7)			
Pairwise	b, c	a	a, d	a, c	b, c, d	b	b			

Data are expressed as mean ± standard deviation unless otherwise stated

Pairwise comparisons are presented as letters pairwise with deferent letters have a statistical significant difference and pairwise with similar letters have non statistical significant difference.

F value: Mauchly's Test of Sphericity(Greenhouse-Geisser/Sphericity Assumed), η^2: Partial Eta Squared, χ^2: Chi-square test, *p* is significant if ≤ 0.05, SD: Standard Deviation, PPR: Peripheral pulse rate, HR: Heart rate, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, MBP: Mean blood pressure, Temp: Body Temperature, CVP: Central Venous Pressure

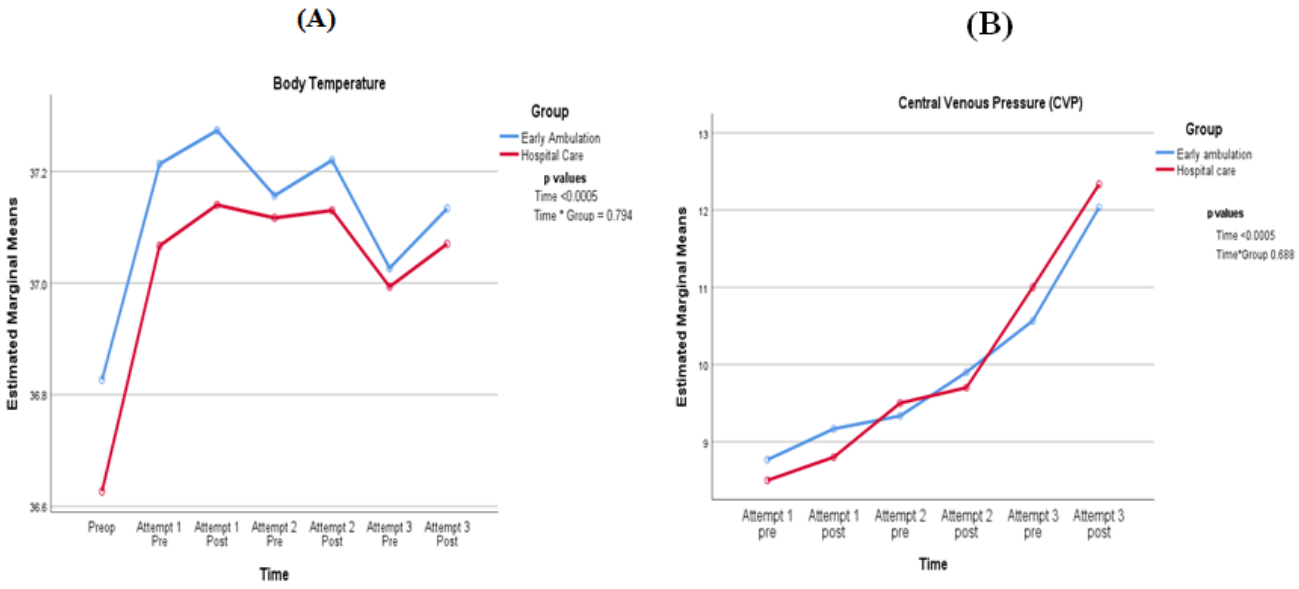

Figure 3. Comparison between pre and postoperative perfusion indices among groups

4. Discussion

Cardiac surgical patients often have poor cardiovascular reserve postoperatively [33]. Postoperative management for CSPs is a crucial and a timely manner comprehensive health approach [10]. EA has always been a polemic topic in caring CSPs [33]. Brustia [2] assessed the early mobilization influencing elderly patients post abdominal aortic surgery. They displayed that early mobilization hastened patients' recovery, and improved postoperative outcomes. Stephens & Whitman [30] stated that the burden hemodynamic is the key indicator during early postoperative time. EA is a challenge with a significant priority of nursing practice in the ICUs [34]. CCNs' awareness of EA value for CSPs' outcomes is the main concern to sustain hemodynamic stability and adequate organ perfusion [10].

The current study depicts no statistically significant differences between EA and HC groups in relation to their basic health data and preoperative hemodynamic and perfusion indices. This exhibits the similarity of the two groups. Thereby, any variation between them can be related to the application of early ambulation schedule merely. These findings were confirmed by Ahmed et al., [26], who investigated the impact of early activity on cardiac surgical patients' outcome postoperatively. Additionally, Arbane et al., [35], found the same findings. Kim & Kim [36], examined the effect of semi-fowlers position on forty laparoscopic abdominal surgery patients. They noticed that this position enhanced the postoperative

recovery scores effectually with no association between hemodynamic parameters and patients' basic characteristics.

Our research findings illustrated that PP and heart rates were slightly increased in HC group than EA group with statistically significant differences over time. However, SBP, DBP and MAP were raised in the EA group than HC group with statistically significant differences in DBP and MAP over time and no statistically significant differences in SBP. One possible explanation for these findings could be due to increased oxygen demand [1] during mobilization, activation of sympathetic nervous system [19] and wound pain that can raise hemodynamic readings [16]. Our results are consistent with Camargo et al., [37] and Younis & Ahmed [38], who detected a significant increase in mean score of heart rate after passive exercise among mechanically ventilated patients. Additionally, Asgari et al., [23] noticed a significant difference in heart rate during the first and third day of mobilization between the intervention and control groups. Also, the effect of ambulation on hemodynamic values among critically ill patients was studied by Stiller, Phillips, & Lambert [39], who reported significant changes in heart rate with minor clinical importance after patients' ambulation.

On the contrary, El-Sayed **[25]** and Ahmed et al., [26], reported that the early activity group has significant increase in PP and heart rates postoperatively throughout the study period and in most hours for the control group. However, other investigators found no relation between heart rate readings and therapeutic positions [10] or passive exercise [40] of the studied patients. In the same view, previous and recent studies noted no significant change in heart rate in relation to critically ill patients' mobilization [16,22,41] or after large surgery [2].

Our findings are supported by El-Sayed **[25]** and Ahmed et al., [26], who noted that SBP was significantly increased in the early activity group and decreased in the control group postoperatively, while DBP decreased only in the early activity group. Senduran et al., [16], eminent increased SBP and MAP immediately after the second physiotherapy task among liver transplantation patients. Likewise, Camargo et al., [37], noticed an elevation in SBP and DBP during the exercise sessions. Conversely, Stiller, Phillips, & Lambert [39], reported significant changes in arterial blood pressure with minor clinical importance after patients' mobilization.

On the contrary, no significant changes in MAP readings were detected during passive exercise [37] or patients' positioning [10] or after mobilization of open aortic surgery patients [2]. Also, they reported that mobilization was feasible and safely achieved to critically ill patients. Moreover, Anchala [10] and Burtin et al., **[40]**, noticed no relation between SBP and DBP readings and exercise schedule with highly significant difference between the study group and control group.

The present study results depict that perfusion indices regarding CVP and body temperature were increased in EA and HC groups with minor raise among EA patients compared with HC patients. Despite most of EA patients return to their normal CR time rapidly but most of HC patients delayed. Moreover, all perfusion indices showed a statistical significance difference over time post-mobilization. These findings are consistent with El-Sayed **[25]** and Ahmed et al., [26], who reported an increase in CVP, body temperature values in experimental and control groups throughout the study period. However, the capillary refill time was delayed significantly in the control group postoperatively. Parallel to our current results, Camargo et al., [37] and Genc, Koca & Gunerli [42], found a significant raise in CVP readings between rest value and recovery period values after passive exercise sessions for mechanically ventilated patients.

On the contrary, Younis & Ahmed [38], reported that no significant changes in the CVP mean values over their study phases. The same findings were stated by Adler & Malone [43], who examined the hemodynamic response to early ambulation among critically ill patients.

Overall, the current study findings supported the allied studies that showed positive effect of EA on patients' hemodynamic and perfusion indices postoperatively. EA for CSPs is a safe, viable and easy nursing task. Thereby, the current results supported our research hypothesis that early ambulation attributes significant positive effect on patients' hemodynamic and perfusion indices post each ambulation attempt throughout the study period.

5. Conclusion

The current study showed the positive effect of EA on CSPs' hemodynamic and perfusion indices postoperatively. Overall, the present findings are supported by other related studies that EA for CSPs is easy, applicable and safe nursing task that can improve the postoperative patients' outcomes. Thus, EA schedule should take a high priority in nursing care for CSPs. EA should be integrated in nursing courses. CCN should attend EA refreshing workshops periodically to enhance their awareness about the significance and benefits of EA for those patients outcome. Further research studies are required to investigate the long term effect and benefits of EA for cardiac surgical and critically ill patients. Additional studies are recommended to design EA algorithms for critically ill patients in different sittings.

5.1. Limitations of the Study

The patients enrolled in the study were from one unit in main Mansoura University hospitals that limits the generalization of the data. The findings of the current study was limited to short term duration that investigated the patients hemodynamic and perfusion indices after EA in the first surgical day. Each attempt had short duration that might hinder the assessment of patient's ambulation tolerance. Patients' pain level and intensity were not considered in the present study.

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Conflict of Interest

No conflict of interest has been declared by the author.

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