Hemodynamic challenge to early mobilization after cardiac surgery: A pilot study

Cassina, Tiziano; Putzu, Alessandro; Santambrogio, Luisa; Villa, Michele; Licker, Marc Joseph

Abstract: BACKGROUND: Active mobilization is a key component in fast-track surgical strategies. Following major surgery, clinicians are often reluctant to mobilize patients arguing that circulatory homeostasis would be impaired as a result of myocardial stunning, fluid shift, and autonomic dysfunction. AIMS: We examined the feasibility and safety of a mobilization protocol 12-24 h after elective cardiac surgery. SETTING AND DESIGN: This observational study was performed in a tertiary nonacademic cardiovascular Intensive Care Unit. MATERIALS AND METHODS: Over a 6-month period, we prospectively evaluated the hemodynamic response to a two-staged mobilization procedure in 53 consecutive patients. Before, during, and after the mobilization, hemodynamics parameters were recorded, including the central venous oxygen saturation (ScvO 2), lactate concentrations, mean arterial pressure (MAP), heart rate (HR), right atrial pressure (RAP), and arterial oxygen saturation (SpO 2). Any adverse events were documented. RESULTS: All patients successfully completed the mobilization procedure. Compared with the supine position, mobilization induced significant increases in arterial lactate (34.6% [31.6%, 47.6%], P = 0.0022) along with reduction in RAP (-33% [-21%, -45%], P < 0.0001) and ScvO 2 (-7.4% [-5.9%, -9.9%], P = 0.0002), whereas HR and SpO 2 were unchanged. Eighteen patients (34%) presented a decrease in MAP > 10% and nine of them (17%) required treatment. Hypotensive patients experienced a greater decrease in ScvO 2 (-18 ± 5% vs. -9 ± 4%, P = 0.004) with similar changes in RAP and HR. All hemodynamic parameters, but arterial lactate, recovered baseline values after resuming the horizontal position. CONCLUSIONS: Early mobilization after cardiac surgery appears to be a safe procedure as far as it is performed under close hemodynamic and clinical monitoring in an intensive care setting.

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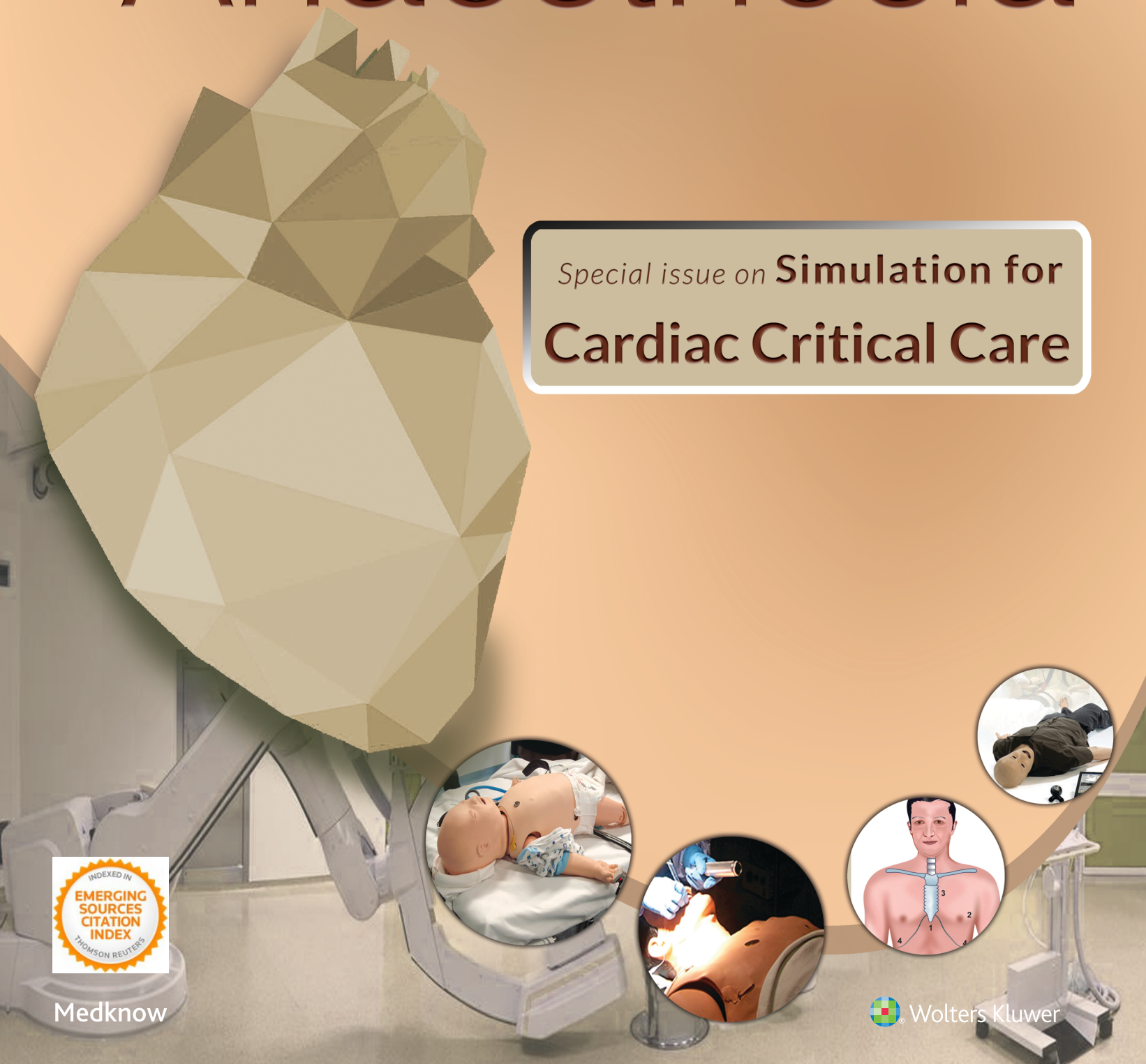

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Hemodynamic challenge to early mobilization after cardiac surgery: A pilot study

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ABSTRACT

Background: Active mobilization is a key component in fast-track surgical strategies. Following major surgery, clinicians are often reluctant to mobilize patients arguing that circulatory homeostasis would be impaired as a result of myocardial stunning, fluid shift, and autonomic dysfunction. **Aims:** We examined the feasibility and safety of a mobilization protocol 12–24 h after elective cardiac surgery. **Setting and Design:** This observational study was performed in a tertiary nonacademic cardiovascular Intensive Care Unit. **Materials and Methods:** Over a 6-month period, we prospectively evaluated the hemodynamic response to a two-staged mobilization procedure in 53 consecutive patients. Before, during, and after the mobilization, hemodynamics parameters were recorded, including the central venous oxygen saturation ($ScvO_2$), lactate concentrations, mean arterial pressure (MAP), heart rate (HR), right atrial pressure (RAP), and arterial oxygen saturation (SpO_2). Any adverse events were documented. **Results:** All patients successfully completed the mobilization procedure. Compared with the supine position, mobilization induced significant increases in arterial lactate (34.6% [31.6%, 47.6%], P = 0.0022) along with reduction in RAP (−33% [−21%, −45%], P < 0.0001) and $ScvO_2$ (−7.4% [−5.9%, −9.9%], P = 0.0002), whereas HR and SpO_2 were unchanged. Eighteen patients (34%) presented a decrease in MAP > 10% and nine of them (17%) required treatment. Hypotensive patients experienced a greater decrease in $ScvO_2$ (−18 ± 5% vs. −9 ± 4%, P = 0.004) with similar changes in RAP and HR. All hemodynamic parameters, but arterial lactate, recovered baseline values after resuming the horizontal position. **Conclusions:** Early mobilization after cardiac surgery appears to be a safe procedure as far as it is performed under close hemodynamic and clinical monitoring in an intensive care setting.

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Key words: Anesthesia; Cardiac surgery; Hemodynamics; Hypotension; Perioperative care

INTRODUCTION

Over the past two decades, clinical pathways have been widely developed in medicine and the concept of fast-track surgery has emerged aiming to apply evidence-based clinical care in order to accelerate the postoperative recovery period. Modern perioperative care is driven by standardized protocols emphasizing the importance of minimally invasive surgery, the utilization of short-acting anesthetic agents, goal-directed fluid titration, multimodal analgesic regimen, as well as early withdrawal (or avoidance) of intravascular, gastric or bladder catheters and drainage tube. Several randomized controlled trials have demonstrated that fast-track strategies significantly reduce the length of hospital stay and spare medical

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costs while providing similar clinical outcomes after various types of surgical procedures.[1-3]

In cardiac surgery, application of fast-track perioperative regimen has been shown to allow earlier extubation, to alleviate nursing workload, and to shorten the stay in the Intensive Care Unit (ICU). However, scant attention has been drawn to the mobilization process that should be considered a key step in postoperative rehabilitation programs.[4-6] Noteworthy, concerns have been raised regarding inadequate hemodynamic response to changes in body position in patients recovering from prolonged anesthesia and with myocardial stunning associated with ischemia-reperfusion injuries. Previous studies[7-9] have reported that cardiac surgical patients being mobilized 12–18 h postoperatively have a marked reduction in the central venous oxygen saturation ($ScvO_2$), suggesting an imbalance between systemic oxygen delivery and tissue oxygen consumption. In the daily ICU practice, failed mobilization is often related to the occurrence of symptomatic orthostatic hypotension that requires appropriate therapy before transferal to the surgical floor.

In this observational study, we described the hemodynamic response to active mobilization in consecutive patients recovering from cardiac surgical procedures and by assessing the safety profile, we discriminated patients poorly tolerant to this orthostatic challenge.

MATERIALS AND METHODS

This prospective cohort study was conducted in a Swiss tertiary nonacademic cardiovascular ICU from September 2009 to March 2010. The study was approved by the Institutional Research Board and informed consent was obtained from each patient who met the eligibility criteria. The study population included consecutive patients scheduled to undergo elective cardiac surgery, either isolated coronary artery bypass grafting (CABG) with or without cardiopulmonary bypass (CPB), aortic valve replacement (AVR), or combined CABG and AVR. Exclusion criteria consisted of age <18 years, the use of thoracic epidural analgesia, and the presence of severely impaired cardiac function as defined by the left ventricular ejection fraction <20% or the need for preoperative inotropic support or intra-aortic balloon pump. Postoperatively, patients were secondarily excluded if they presented neurological impairment, hemodynamic instability, metabolic acidosis (blood lactate >3 mmol/L), or persisting pain (visual analog scale [VAS] >4/10) that precluded mobilization. All patients were managed by the same team of cardiac surgeons and anesthetists in the operating theater and in the ICU.

The usual medications were continued on the morning of the procedure, except for oral anticoagulants. All patients received benzodiazepine (midazolam, oxazepam, or lorazepam) 30 min before anesthesia induction and were equipped in the operating theater with an invasive arterial catheter, a central venous line, and a bladder catheter. Standardized anesthesia management consisted in a propofol induction with intermittent administration of opiates (fentanyl) and myorelaxants (vecuronium). After tracheal intubation and institution of mechanical ventilation, a transesophageal echocardiographic (TEE) probe was introduced and used as standard intraoperative monitoring. After full heparinization, normothermic CPB was started using a membrane oxygenator (nonpulsatile flow 2.2–2.5 L/min/m^2) and with alpha-stat control for acid-base management. During aortic cross-clamping, myocardial protection was achieved by intermittent anterograde cold blood cardioplegia through the aortic root and mean arterial pressure (MAP) was maintained between 50 and 70 mmHg with vasoactive medications as necessary. Weaning from CPB was guided by TEE assessment and hemodynamic measurements. In addition to fluid loading, electrical atrioventricular pacing, vasopressors, and/or inotropes drugs were introduced to target specific hemodynamic endpoints: Preload optimization based on direct heart visualization and left ventricle end-diastolic diameter, MAP between 65 and 100 mmHg, and heart rate (HR) between 70 and 100 beats/min. At the end of the surgical procedure, core body temperature was maintained above 35.5°C and the patients were transferred to the ICU.

In the ICU, if blood loss through the chest drain was <150 ml/h and hemodynamic condition remained stable, respiratory weaning with adaptive support ventilation was started and the patient was extubated as soon as possible as far as all safety criteria of our fast-track strategy were fulfilled as detailed elsewhere.[10] Patients were kept comfortable (target pain VAS <3/10) by intravenous titration with opiates (morphine 1–4 mg/h or fentanyl 20–40 mcg/h), in addition to acetaminophen (1 g/6 h).

On the morning of the 1st postoperative day, a standardized 35–40 min mobilization trial was attempted by the

nursing team, while ECG and invasive pressures were monitored and the patient was observed for clinical signs of intolerance (e.g., dizziness, blurred vision, and nausea). Starting from the horizontal resting position, the patient was first placed sitting on the bed for 5 min with feet on the floor, then he was moved to an armchair for 30 min, and finally returned to the initial recumbent position. Before each mobilization, the pressure transducers were zeroed, aligning the reference point to the fifth intercostal space in the mid-axillary line.

Five minutes before mobilization (T0), 10 min after sitting (T1) on the armchair, and 10 min after returning to bed (T2), central venous blood was sampled and the following data were recorded: HR, MAP, right atrial pressure (RAP), arterial oxygen saturation (SpO_2), $ScvO_2$, and lactate concentrations.

Discharge criterions from ICU to ward included: Toleration of mobilization, absence of vasoactive treatment, stable hemodynamic, satisfactory respiratory conditions, unnecessary of invasive monitoring, and no further active interventions planned.

The safety profile was the primary study endpoint as determined by the onset of arterial hypotension (decrease in MAP >10%), and supraventricular or ventricular arrhythmias.

The results are presented as median with interquartile range, mean with 95% confidence interval (standard deviation) or number with percentage (%) as appropriate. To assess the hemodynamic and $ScvO_2$ changes during mobilization, analysis of variance for repeated measurements was used and followed by pairwise Student's *t*-tests for *post hoc* analyses with Bonferroni correction according to the number of comparisons. Statistical significance was set at 0.05. All the statistical analyses were performed with the commercially available JMP Statistical Discovery software 7.0 (SAS Institute, Cary, NC, USA).

RESULTS

We considered 184 consecutive patients: 124 were secondarily excluded (58 not elective surgical procedures, 42 for epidural combined analgesia, 16 with unstable hemodynamic conditions, seven because needed re-operation for blood loss, one for transitory neurological deficit, and seven refused to participate in the study). Finally, 53 patients were included in the present study [Figure 1].

Baseline characteristics are presented in Table 1. The majority of patients were male (64%), older than 70 years old (57%), with chronic hypertension (79%), with a EuroSCORE of 6.3 ± 3.5 points, and underwent isolated CABG surgery (68%). All patients could be weaned from the ventilator within the first 4 postoperative h. In the 12 h before mobilization, the patients received a total of 12 ± 6.4 mg of morphine or 182 ± 43 mcg/h of fentanyl, with a median VAS of 0 (0, 3) at mobilization. The mean hemoglobin level at mobilization was 9.87 ± 1.17 mg/dL and the mean cumulative fluid balance was

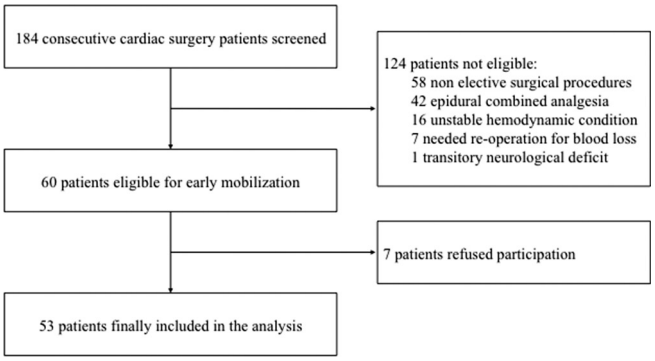

Figure 1: Patient flow diagram

Table 1: Demographic, comorbidity, and surgery baseline characteristics of the 53 patients

Characteristics	*N* = 53
Demographics	
Age (years)	69.1±10.4
Female, *n* (%)	19 (35.85)
EuroSCORE	6.3±3.5
Weight (kg)	77.9±13.2
Body mass index (kg/m^2)	28.0±4.2
Body surface area (m^2)	1.8±0.4
Comorbidity, *n* (%)	
Arterial hypertension	42 (79.24)
Diabetes mellitus	18 (33.96)
Chronic obstructive pulmonary disease	4 (7.55)
Peripheral vasculopathy	10 (18.87)
Chronic renal failure	4 (7.55)
Stroke	4 (7.55)
Myocardial infarction	24 (45.28)
Other comorbidity	13 (24.53)
Surgery	
Isolated CABG, *n* (%)	36 (67.92)
Aortic valve surgery, *n* (%)	12 (22.64)
Combined CABG and aortic valve surgery, *n* (%)	5 (9.43)
Off-pump operation, *n* (%)	7 (13.21)
Cardiopulmonary bypass time (min)	91.7±52.6
Fentanyl intraoperative dose (mcg)	1136±345

Data expressed as mean and SD or as median and IQR, as appropriate. CABG: Coronary aortic bypass grafting, SD: standard deviation, IQR: interquartile ratio

1858 ml (−380, 4606) on day 1. The median time from ICU admission to mobilization was 20.3 h (19, 21.4). At that time, 17 patients were still receiving low-dose inotropes (dobutamine, $n = 6$), low-dose vasopressor (norepinephrine, $n = 13$), or both drugs ($n = 2$) to stabilize their hemodynamic condition [Table 2].

All patients successfully completed the mobilization protocol without experiencing myocardial ischemia or other major complications. Eighteen patients presented a significant decrease in MAP but only nine of them required treatment: Seven received additional intravenous fluids (median 500 ml) and two received vasopressor support (low-dose norepinephrine infusion). Seven patients complained of self-limiting nausea with one of them felt transiently dizzy and three patients presented self-limited arrhythmias (two sinus tachycardia and one paroxysmal supraventricular arrhythmia).

Table 2: Postoperative data and outcomes of the 53 patients

Outcomes	*N* = 53
Median time from ICU admission to mobilization (h)	20.3 (19-21.42)
Duration of postoperative mechanical ventilation (h)	3 (1.75-4)
Mobilization time (min)	79 (32-240)
Length of ICU stay (h)	24.75 (23.3-36.3)
Re-admission rate in ICU (%)	1 (1.89)
Need for vasopressor support at mobilization (%)	13 (24.53)
Vasopressor support at mobilization (norepinephrine, μg/kg/min)	0.038 (0.029-0.051)
Need for inotropic support at mobilization (%)	6 (11.32)
Inotropic support at mobilization (dobutamine, μg/kg/min)	1.23 (1.06-2.70)
Hemoglobin (mg/dL)	9.87±1.17
Fluid balance at postoperative day 1 (mL)	1858 (−380-4606)
Complications of mobilization (%)	
Hypotension*	9 (16.98)
Nausea	7 (13.21)
Arrhythmia	3 (5.66)
Hospital length of stay (days)	9 (8-11)
Postoperative 28-day mortality (%)	2 (3.77)

Data expressed as median and IQR, mean and SD, or number of cases and percentage as appropriate. *Defined as mean arterial pressure <10% baseline needing active intervention. ICU: Intensive Care Unit, SD: Standard deviation, IQR: Interquartile range

The hemodynamic parameters recorded before, during, and after mobilization are reported in Figures 2 and 3. Compared with the recumbent position, the patients presented an increased blood lactate (34.6% [31.6%, 47.6%], $P = 0.0022$) and a significant reduction in RAP (−33% [−21%, −45%], $P < 0.0001$) and $ScvO_2$ (−7.4% [−5.9%, −9.9%], $P = 0.0002$). MAP, HR, and SpO_2 did not change significantly. As shown in Figure 4, a greater decrease in $ScvO_2$ was observed among "hypotensive patients" compared with "non-hypotensive patients" (−18 ± 5% vs. −9 ± 4%, $P = 0.004$) that was accompanied by similar changes in HR, RAP, and C-reactive protein (227 ± 72 vs. 214 ± 56 mg/L, P value not significant). Noteworthy, hypotensive and nonhypotensive patients did not differ in terms of preoperative and procedural characteristics.

After resuming the initial recumbent position, RAP and $ScvO_2$ recovered basal values, whereas blood lactate levels remained significantly increased [Table 3].

Postoperative data and outcomes are presented in Table 2. All patients were discharged from the ICU after a median stay of 25 h (23, 36). The 28 days mortality rate was 3.77% ($n = 2$, one case due to mesenteric ischemia and one case due to multiple organ dysfunction due to heparin-induced thrombocytopenia type II). Five

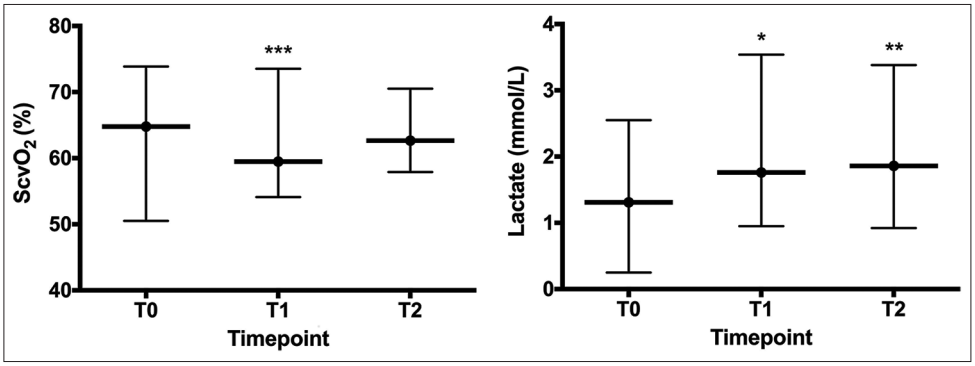

Figure 2: Central venous oxygen saturation and arterial lactate values in supine bed resting (T0), after 10 min in sitting position (T1), and 10 min after returning in bed (T2). Line is median value and whiskers are the 1st and 3rd quartile (***$P < 0.05$ T1 vs. T0 and T2; **$P < 0.05$ T2 vs. T0; *$P < 0.05$ T1 vs. T0)

patients presented other complications in the surgical ward ($n = 3$, transient neurological impairment; $n = 1$, atrial fibrillation; and $n = 1$, pulmonary atelectasis).

DISCUSSION

The main finding of this study is that early mobilization in cardiac surgery patients is a safe procedure in an intensive care setting, with few adverse events, even if it could be associated with significant hemodynamic alterations.

Mobilization plays an important role as a part of fast-track approach to enhance postoperative recovery and decrease convalescence time.[3-4] Fast-track should not be limited to rapid extubation but it is a process concerning all the perioperative management.[5] Until now, early postoperative mobilization has been evaluated in physiologic studies with complete hemodynamic measurements by more or less invasive methods, in which mobilization represents simply the effort test chosen in the experimental design to investigate the cardiocirculatory response after general anesthesia and various types of surgery. Previous studies showed impairment in postoperative postural cardiovascular response after cardiac[7-9] and major abdominal surgery[11] but not after breast surgery.[12]

During mobilization procedure, a part of the thoracic blood is translocated downward and then the venous pooling increases. The venous return to the heart results inadequate, even if the decrease in RAP should cause the conversion of unstressed volume to the stressed volume.[13] This compensatory mechanism alone is not enough to satisfy the O_2 demand, resulting in an unbalance condition. This pathophysiological process is accentuated by vasoplegia, capillary leak, and relative postoperative hypovolemia.

Circulatory and neurologic feedback mechanisms are required to maintain cerebral perfusion and consciousness in front of the hydrostatic change.[14]

The orthostatic response is complex, including muscle pump against venous blood pooling, autonomic control of the arterial resistances to limit blood

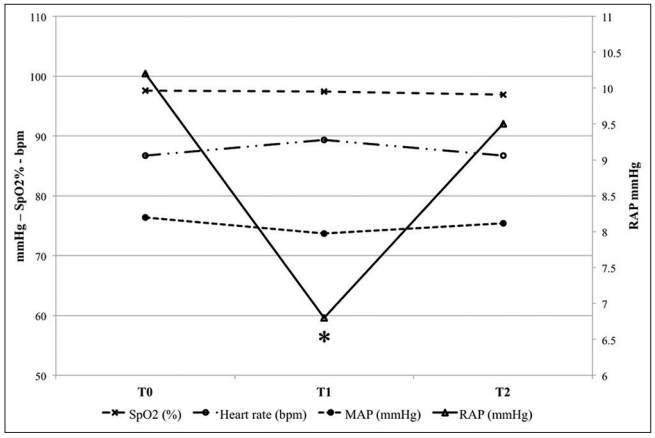

Figure 3: Hemodynamic parameters during mobilization: mean arterial pressure, heart rate, arterial oxygen saturation, and right atrial pressure. Data expressed as mean (*P < 0.05 T1 vs. T0 and T2)

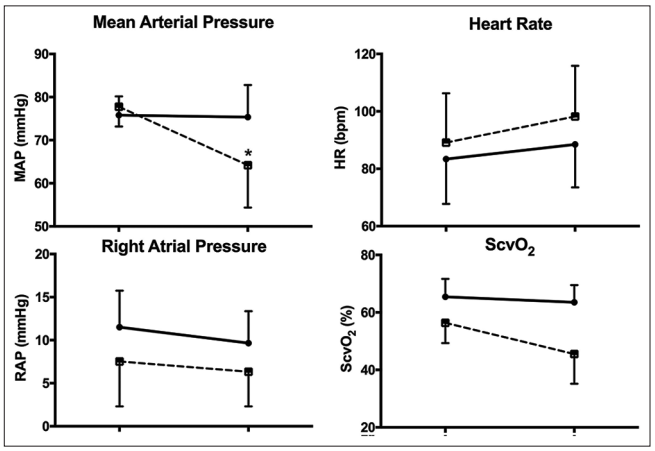

Figure 4: Comparison of mean arterial pressure, heart rate, central venous oxygen saturation, and right atrial pressure during mobilization in patients who experienced (black square and dotted line) or not (black circle and continuous line) a fall in mean arterial pressure >10% (*P < 0.05 vs. baseline)

Table 3: Hemodynamic parameters during first postoperative mobilization, in supine bed resting position (T0), after 10 min in sitting position (T1), and 10 min after returning in bed (T2)

	T0	T1	T2	*P*		
				T0 versus T1	T0 versus T2	T1 versus T2
Heart rate (bpm)	86.7±15.6	89.3±15.4	86.7±14.3	0.3720	0.9897	0.3651
MAP (mmHg)	76.4±7.0	73.7±8.9	75.4±9.5	0.1010	005586	0.2890
RAP (mmHg)	10.2±4.0	6.8±4.3	9.5±4.5	<0.0001	0.4134	0.0009
SaO_2 (%)	97.6±1.6	97.4±1.9	96.9±2.1	0.5319	0.0592	0.2046
$ScvO_2$ (%)	64.3±5.7	59.5±7.5	62.4±6.2	0.0002	0.1222	0.0215
Lactate (mmol/L)	1.4±0.6	1.8±0.7	1.9±0.8	0.0022	<0.0001	0.2841

Data expressed as mean and SD. MAP: Mean arterial pressure; RAP: Right atrial pressure; SaO_2: Arterial blood oxygen saturation; $ScvO_2$: Central venous blood oxygen saturation, SD: Standard deviation

flow to the extremities and splanchnic vascular bed, local metabolic mechanisms and delayed neurohumoral effects with the activation of the renin-angiotensin-aldosterone system, and the releasing of epinephrine and vasopressin. In healthy subjects, the integration of the described systems can maintain blood pressure values, even if the cerebral arterial pressure results decreased, since the hydrostatic column between heart and brain. The physiologic postural hemodynamic changes should include an increase in HR (10–30 beats/min), a nonsignificant reduction in systolic blood pressure with an increase in diastolic and mean blood pressure: Consequently, pulse pressure decrease.[15]

Kirkeby-Garstad *et al*.[8-9] demonstrated that the patients in the early postoperative period after CABG and AVR exhibit a marked desaturation when mobilized, revealing an inadequate cardiovascular response. Furthermore, Bungaard-Nielsen *et al*.[11] found the same impaired response in patients that underwent radical prostatectomy. Their studies did not discuss if early mobilization represents an advantage for the patients in fast-tracking recovery or if it is safe in these hemodynamic conditions. A more recent trial showed that early postoperative orthostatic intolerance associated with an impaired cardiovascular orthostatic response is common in patients that underwent total hip replacement.[16]

The results of the present study confirm the increased oxygen consumption during early mobilization which was not compensated by a normal response to the effort: HR and MAP remain constant, but RAP and $ScvO_2$ decrease significantly in sitting position and restore in returning to bed. The arterial lactate level is increased during all the procedure also after the return in bed [Figure 2], but always below the cutoff value of 3 mmol/L, which identifies the patients at higher postoperative risk.[17] The modest physical effort done during early mobilization represents a metabolic imbalance between oxygen demand and supply after cardiac surgery. Our results showed only a slight increase in lactate plasma level, fortunately without clinical relevance, provided an accurate management in an intensive clinical setting.

The $ScvO_2$ was 64% in starting position, showing that patients after cardiac surgery were already in compensatory mode[18] with mobilization $ScvO_2$ decrease under 60% and in nine patients under 50% (minimum 42.7%).

The results from the "hypotensive patients" showed a significant greater decrease in $ScvO_2$ indicating a subclinical deficit of perfusion; in fact, only nine patients necessitated of therapeutic intervention with the fluid infusion (seven patients) or a vasopressor support (two patients) and only two patients presented MAP <60 mmHg. Therefore, mobilization represents a dynamic test involving the activation of the compensatory mechanisms, leading to a deficit of tissue perfusion as highlighted by $ScvO_2$ alone. Particular attention should be given to the decrease in MAP. This subgroup did not present significant variation in other hemodynamic and inflammatory parameters.

There was no correlation between $ScvO_2$ desaturation and clinical symptoms (e.g., hypotension, nausea, or dizziness). An early goal directed therapy with fluids, inotropes, or vasopressors has been proposed to maximize oxygen delivery after cardiac surgery[19] and critically ill patients,[20] but recently several doubts rose about this protocol-based approach.[21] In other critical care fields,[22] the $ScvO_2$ is retained a reliable parameter for weaning procedure. Our data collection showed a mismatch between clinical course and $ScvO_2$ suggesting that it could not be considered a target of therapy in this setting. The response to mobilization observed in our patients is lacking in tachycardia, and also the blood pressure compensation is variable: Only about half of the patients presented a correct increase in diastolic pressure and a consequent pulse pressure decrease. Despite the difficulties in hemodynamic compensation, 35 patients tolerated mobilization very well. The response to mobilization resulted independently from the type of cardiac surgery, the age, the ejection fraction, the fluid balance, or initial RAP.

The main symptom of intolerance was hypotension in nine patients, in which the therapy of the first choice was fluids administration as the adequate blood volume is a prerequisite for an orthostatic response.[23] One patient presented transient symptoms of cerebral hypoperfusion as dizziness; nausea instead resulted in difficult interpretation for the analgesic therapy with opiate agents, but all the patients were responsive to pharmacologic therapy.

The most frequent worries to the mobilization of a cardiac surgery patient are the sternal diastasis and the hemorrhagic risk, both did not occur in our group of patients. No such complications resulted directly related to the mobilization.

No increase in overall complications was observed with the introduction of mobilization procedure. in particular, no reintubation and no respiratory complications were observed. The advantages of sitting position on the pulmonary system (e.g., compliance and atelectasis prevention) are well documented in the literature[24-25] and their description is beyond the aim of the study. The reported incidence of respiratory failure after cardiac surgery, depending on the definition assumed, ranges between 5% and 20%.[26] In our study cohort, no respiratory complications requiring mechanical ventilation were registered, supporting that mobilization is one of the strategies for the reduction of perioperative pulmonary complications as described in the guidelines proposed for noncardiac surgery.[27]

The early mobilization after cardiac surgery, in our opinion, is a safe and feasible procedure to be performed under clinical and hemodynamic monitoring in an intensive care setting. Our observations showed that early mobilization after cardiac surgery represents a physical effort not completely compensated as proven by the $ScvO_2$ desaturation and the increase in lactic acid level. The duration of this cardiovascular impairment is unknown: Kirkeby-Garstad *et al*.[8] showed that it is still present at 48 h after cardiac surgery. The previous studies described this phenomenon but they did not indicate the causes, which may be, in our opinion, multifactorial: The impact of general anesthesia on baroreceptor function,[27] the systemic inflammatory response syndrome after major surgery, and the chronic antihypertensive preoperative therapy, while the postoperative myocardial dysfunction should not affect the response to early mobilization.[28]

CONCLUSIONS

On the basis of our observations, early mobilization is an important part of perioperative cardiac surgery care, showing few adverse events and may contribute to decrease the incidence of perioperative complications, in particular, respiratory complications. Due to cardiovascular system impairment after cardiac surgery, mobilization should be performed under strict clinical and hemodynamic monitoring in an intensive care setting, with particular attention to blood lactate and central venous saturation. Mobilization, in these conditions, is safe and could be considered as ICU discharge criteria after cardiac surgery.

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Conflicts of interest

There are no conflicts of interest.

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