

Effect of Postoperative Active Warming of Patient after Coronary Artery Bypass Graft Surgery on Hemorrhage and Blood Transfusion

Hamide Dehghani¹; Razie Zare Bezg Abadi^{2*}; Mehdi Haddadzade³; Ali Dehghani⁴

¹Department of Medical-Surgical Nursing, Faculty of Nursing and Midwifery, Shahid Sadoughi University of Medical Science, Yazd, Iran

²Department of Intensive Care Nursing, Faculty of Nursing and Midwifery, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

³Department of Cardiac Surgery, Faculty of Medicine, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

⁴Department of Epidemiology and Biostatistics, Faculty of Public Health, Shahid Sadoughi University of Medical Sciences, Yazd, Iran

*Correspondence to

Razie Zare Bezg Abadi; MSc of Intensive Care Nursing Student, Faculty of Nursing and Midwifery, Shahid Sadoughi University of Medical Sciences, Yazd, Iran.
Tel: +989132734514;
Email: zare.razie1@gmail.com

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Abstract

Background and Aim: Postoperative hemorrhage is a common complication following coronary artery bypass graft (CABG) surgery. Warming the patient may be effective on postoperative hemorrhage and blood transfusion. The main objective of this study was to determine the effect of postoperative active warming of the patient on hemorrhage and blood transfusion after off-pump CABG surgery.

Methods: This single-blinded randomized clinical trial was performed on 60 candidates. The patients undergoing CABG surgery were randomly allocated to case and control groups. Members of the case group (n=30) were actively warmed postoperatively by Warm Touch™ 5800 after admission in intensive care unit (to reach a temperature up to 36.7°C). In the control group (n=29), a bed sheet, was applied as the routine intervention. Blood loss and need for blood transfusion were assessed in both groups during the first 24 hours after surgery. For statistical analysis, chi-square and independent sample *t* test were used.

Results: There was no significant difference between the two groups in terms of age, sex, weight, left ventricular ejection fraction and preoperative tests. Mean chest tube drainage was significantly lower in the Warm Touch group than the control group within 6 and 24 hours after surgery ($P=0.046$ and $P=0.041$ respectively). In addition, the difference between the two groups was not significant as for blood transfusion 24 hours following the operation.

Conclusion: Warming of patients after CABG surgery reduces postoperative hemorrhage but does not affect blood transfusion.

Keywords: Coronary artery bypass, Hypothermia, Hemorrhage, Blood transfusion.

Introduction

As a common complication in patients undergoing coronary artery bypass graft (CABG) surgery, hemorrhage plays an important role in the pathogenesis and postoperative mortality (1,2). Three to 14% of the cases show severe hemorrhage after CABG surgery and according to the reports, 5% of such patients might need chest reopening to control hemorrhage. Thirty percent of the patients undergoing CABG surgery require blood transfusion such that an annual 10%-15% of all the blood product supplies in the United States are consumed by these patients (1).

Hemorrhage results in decreased cardiac output and the consequent incidence of tachycardia and hypertension,

which might in turn lead to increased postoperative workload of the heart and a slower process of patient recovery (3). Furthermore, blood transfusion is followed by numerous complications which can ultimately lead to increased length of hospitalization and excessive costs (4). Hemorrhage after CABG surgery may result from surgical trauma, lack of heparin neutralization at the end of operation or coagulation factors disorder, and the formed platelets (1,5).

Among the important factors concerning postoperative hemorrhage and coagulation disorders is hypothermia (6). A drop in body temperature in patients undergoing CABG surgery without cardiopulmonary bypass might originate from the cold temperature of the operating

room, heat loss from the wide surgical sites, rinse solutions, cold fluids, poor perfusion environment and disorder in the regulation of body temperature due to the effect of anesthetic drugs (7,8). Even in normothermic surgery technique without cooling the heart, patient's body temperature reduces up to 35°C (9). In patients with cardiopulmonary bypass surgery, rewarming the patient is conducted in the operating room. This study was performed on patients who underwent off-pump CABG surgery.

Since hypothermia causes coagulation disorder in the form of damage to coagulating enzymes and platelet dysfunction (10-14), warming the patient and elimination of hypothermia may prevent this problem. This is firstly because the coagulation process involves a series of enzymatic reactions the speed of which depends on the temperature of the body. Secondly, the cold temperature leads to the activity of the fibrinolytic system that may cause further damage to homeostasis systems. And thirdly, the bleeding time during mild hypothermia is prolonged because of a defect in the ability of platelets to form thromboxane A₂, which is a platelet aggregation factor (15).

Several studies have investigated the impact of postoperative patient warming on hemorrhage after CABG surgery. Some studies have questioned the impact of warming on the level of patient hemorrhage (16,17), while others have considered patient heating highly effective on hemorrhage. It has been indicated that the creation of normothermic conditions can lead to improved performance of coagulation factors as well as homeostasis maintenance, hence reducing hemorrhage after the operation (8,12,13). According to the results of several studies, patients undergoing cardiac surgery are faced with varying degrees of hypothermia during admission to the intensive care unit (ICU) that may continue for several hours after surgery (7,8). This shows that the problem of post-surgical hypothermia has been largely overlooked. In other words, its complications have been ignored by many authorities. Given that heating the patients using forced air warming system is simple, safe, and cost-effective (18-20), this study aimed to investigate the effect of postoperative active warming of the patient after coronary artery bypass surgery on hemorrhage and blood transfusion.

Methods

As a single-blinded randomized clinical trial, the present study was carried out on 60 candidates for off-pump CABG surgery. The patients were hospitalized in ICU open heart of Afshar hospital in Yazd, Iran. Based on a study by Hofer et al (21), the sample size (n = 26 per group) was calculated considering a confidence level of 95% as well as a test power of 80% using the following formula:

$$n = \frac{2s_p^2[z_1 - \alpha/2 + z_1 - \beta]}{\mu_d^2} \quad S_p^2 = \frac{S_1^2 + S_2^2}{2}$$

The attrition rate was 15% and finally 30 subjects were

studied in each group.

Inclusion criteria were as follows:

- Patients with 30-70 years of age who have undergone off-pump CABG
- Patients with no history of previous CABG
- Having a normal coagulation test as regards prothrombin time, activated partial thromboplastin time, and the platelet count before surgery
- Ventricular outflow ejection fraction >35% (EF≥35%)
- Having an informed written consent to participate in the research, and
- Having no problem in anal area

At the same time, the need for inotropic drugs and postoperative intraaortic balloon pump after surgery, use of cardiopulmonary bypass during surgery, and the need to chest reopening were among the exclusion criteria. It is noteworthy that one of the patients in the control group was excluded from the study as due to hemorrhage from the site of attached graft and sternal dehiscence.

The selected patients for the CABG surgery were introduced to the study after signing the informed consent. To randomize the groups, we used Random Allocation software based on the recommendations from a statistical specialist. The samples were collected during 2 months.

During the study, the temperature of both the operating room and ICU was maintained around 22°C. The prescription of premedication and anesthetic was similar in both groups and the patients underwent the surgery through the median sternotomy by one surgeon. At the end of operations, two chest tubes were inserted into mediastinal and pleura. Similar for all patients, neutralization of injected heparin was carried out based on the activated clotting time (ACT) at the end of the operation. As the patient was transferred to the ICU, the clamp of the chest tubes was opened and the drainage was connected to the bottle. After recording the basic temperature, the case group patients were actively heated using Warm Touch™ 5800. This system increases the body temperature of the patient by producing hot compressed air. In the control group, bed sheet was used as the routine intervention. The core temperature of patients' body in the case group was measured at the beginning and then every 30 minutes until a temperature of 36.7°C was reached. Core temperature was measured through rectum by inserting a probe into the given site as well as monitor controlling. The hemorrhage level measurement was performed by checking the available blood in the graded bottles attached to the patient's chest tube 6 and 24 hours following the operation. Blood transfusion was calculated based on the number of units of packed red blood cells used during the first 24 hours after surgery.

This study was conducted under the permission from the Ethics Committee of Yazd University of Medical Sciences and was registered in the Iranian Registry of Clinical Trials (<http://www.irct.ir/>) with the number IRCT2013111315395N1. Upon completion of the executive stages of the study, data collection forms were completed. Afterwards, the data were encoded and data

analyzed by SPSS (version 15) using chi-square and independent sample *t* test.

Results

In the case group, 18 patients (60%) were male and 12 patients (40%) were female. In the control group, 20 patients (69%) were male and 9 patients (31%) were female ($P=0.589$). The comparison of the mean and standard deviation of parameters such as age, weight, left ventricular ejection fraction, and preoperative tests revealed no statistically significant difference between the two groups (Table 1).

According to independent *t* test results, the mean chest tube drainage was lower in the case group compared with the control group within 6 to 24 hours after surgery such a difference is statistically significant ($P=0.046$ and $P=0.041$ respectively). However, the average number of units of transfused packed red blood cells in the first 24 hours after surgery was not statistically significant in both case and control groups ($P=0.176$) (Table 2).

Discussion

This study aimed to determine the effect of active warming of the patient after CABG surgery on hemorrhage and blood transfusion. According to the findings, the mean drainage of chest tubes was lower in the case (normothermic) group in comparison to the control (hypothermic) group within 6 to 24 hours after operation. In their study, Hofer et al (21) assessed the effect of core body temperature on hemorrhage. They found that 24-

hour postoperative drainage was higher in the hypothermic group compared to normothermic one ($P<0.05$). This finding is consistent with the results of the present study. Rajagopalan et al (12) also conducted a systematic review entitled "The effects of mild perioperative hypothermia on blood loss and transfusion requirement" in a similar domain. The results of their examination suggest a 16% drainage decrease in those of the present research. The results of investigations by Hannan et al (8), Woo et al (13), Ho et al (22) and Hoseini et al (23) are also similar to the findings of our study in this regard. However, Ghiasi et al (6) and Nathan et al (17) showed no clinically significant difference between the case and control groups in terms of hemorrhage during the first 24 hours after surgery, a finding which contrasts with the results of this study. Several studies have shown that mild hypothermia brings about anticoagulant effects that may inhibit the formation of microthrombus during hypothermia. Hypothermia causes coagulation disorder in the form of damage to the coagulating enzymes which, in turn, leads to increased prothrombin time, activated partial thromboplastin time, and platelet dysfunction during hypothermia; hence, increasing the postoperative hemorrhage (10-14). Therefore, warming up the patient and the elimination of hypothermia is effective in the prevention of this problem. Comparison between the number of transfused packed red blood cells within the first 24 hours after surgery in the case and control groups did not reveal a statistically significant difference. A study by Ghiasi et al (6) showed that hypothermia and normothermia do not lead to

Table 1. Comparison of the Mean and Standard Deviation of Preoperative Tests of the Candidate Patients Undergoing CABG Surgery in the Case (Normothermia) and Control (Hypothermia) Groups

Variable	Case Group	Control Group	P Value
	Mean \pm Standard Deviation	Mean \pm Standard Deviation	
Age (y)	57.43 \pm 7.14	59.52 \pm 6.41	0.244
Weight (kg)	71.10 \pm 8.32	72.41 \pm 6.16	0.495
LV ejection fraction (%)	50.03 \pm 7.79	46.6 \pm 8.62	0.127
Prothrombin time (s)	12.8 \pm 0.56	12.8 \pm 0.38	0.701
Partial thromboplastin time (s)	30.53 \pm 4.04	29.92 \pm 6.52	0.677
International normalized ratio	1.06 \pm 0.7	1.07 \pm 0.6	0.440
Hemoglobin (g/dl)	13.93 \pm 2.01	13.50 \pm 1.46	0.164
Hematocrit (%)	41.35 \pm 5.47	41.80 \pm 4.53	0.380
Platelet (No.)	224678 \pm 52328	209920 \pm 54831	0.321

Abbreviation: CABG, coronary artery bypass graft.

Table 2. Comparison of Mean and Standard Deviation of Chest Tube Drainage 6 and 24 Hours After Surgery and Transfusion Packed Red Blood Cells Within the First 24 Hours Following CABG Surgery in Both Case (Normothermia) and Control (Hypothermia) Groups

Variable	Case Group	Control Group	P Value
	Mean \pm Standard Deviation	Mean \pm Standard Deviation	
Chest tube drainage (ml) 6 hours after surgery	306.33 \pm 137.62	392.76 \pm 277.5	0.046
Chest tube drainage (ml) 24 hours after surgery	605 \pm 235.09	808.62 \pm 476.18	0.041
Transfusion of the unit of packed red blood cells in the first 24 hours (No.)	1.43 \pm 0.64	1.88 \pm 0.83	0.176

Abbreviation: CABG, coronary artery bypass graft.

a significant clinical difference in terms of need for the prescription of blood products within the first 24 hours after operation. Their finding confirms the results of the present work. The results of the study by Nathan et al (17) also confirm our findings as for the need for blood transfusion. According to Hofer et al (21), although the level of drainage was higher in the hypothermic group compared with normothermic one, such a difference did not increase the need for transfusion. Like the present research, such a difference between the two groups in Hofer et al was not statistically significant.

Based on studies by Rajagopalan et al (12), Lee et al (15) and Ho et al (22), the need to blood transfusion in the hypothermic group was significantly higher than in the normothermic group. This finding also contradicts the results of the present study. Given the numerous complications of blood transfusion, several cases of hemorrhage might not be intervened by blood transfusion if there is not a considerable hemodynamic drop or if the hemorrhage is on decline.

Conclusion

Based on the findings of this study, postoperative warming of the patient after CABG surgery leads to reduced hemorrhage after surgery. However, it does not have an impact on blood transfusion.

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