A Novel Compression Therapy for Managing Postoperative Orthostatic Hypotension

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ABSTRACT

Post-operative hypotension is most often due to hypovolemia, secondary to surgical blood loss, or vasodilatation due to anesthetic agents. The nurse should take into consideration the nursing measures to minimize it. This study aimed to evaluate the preventive efficacy of a novel lower limb compression bandaging technique in reducing postural hypotension and its associated symptoms among postoperative major surgery patients during positional changes from lying to sitting position. A controlled clinical trial research design on 60 patients undergoing major surgery were recruited and randomly divided into two equal groups: a study group who had a bandage applied in their lower limbs, and a control group with no bandage. A patient assessment sheet was designed by the researcher to record patient data. It consisted of parts for demographic data, medical history, and physical assessment. At the fifth minute, the mean systolic and diastolic blood pressure were statistically significantly higher in the study group compared to the control group. Also, heart rate, and the severity of palpitations and dizziness, were statistically significantly lower in the study group, at the first, third, and fifth minutes of the sitting position, p<0.001. Postural hypotension was less in the study group at the fifth minute. Postural hypotension and its consequences may be largely prevented by prior leg bandaging. The use of elastic bandages is advisable when seating patients post-operatively, especially with major surgery and long bed recumbence. Longer follow-up studies are suggested to assess the long-term effect on postural hypotension, and the possible side-effects of the interventions.

Keywords: Bandaging; Compression; Lower Limb; Postural Hypotension

INTRODUCTION

Orthostatic hypotension (OH) is a well-defined clinical condition characterized by a sustained reduction in systolic blood pressure (≥20 mmHg) or diastolic blood pressure (≥10 mmHg) within three minutes of standing[1]. In healthy individuals, postural changes trigger compensatory mechanisms, including muscle pump activation, venous constriction, and baroreflex-mediated increases in heart rate and cardiac output, to prevent blood pooling in dependent extremities[2]. The pathophysiology of OH involves complex interactions between cardiovascular, autonomic, and neurohumoral systems. Disruptions in these mechanisms—whether due to aging, neuropathy, or surgical stress—can impair cerebral perfusion, leading to symptoms such as dizziness, presyncope, cognitive impairment, and falls[3]. Postoperative OH is particularly concerning, as anaesthesia, immobility, and fluid shifts exacerbate hemodynamic instability[4]. Compression therapy, particularly elastic bandaging, has emerged as a non-pharmacological intervention to mitigate OH by enhancing venous return and reducing peripheral pooling. Modern adaptive compression bandages (e.g., smart textiles, gradient-pressure designs) have shown promise in improving orthostatic tolerance by optimizing hemodynamic responses[5]. However, the mechanisms underlying their efficacy remain under investigation, with recent studies highlighting microcirculatory improvements and baroreflex modulation[6]. Nursing interventions for postoperative OH include hydration management, gradual mobilization, and compression therapy. Recent evidence suggests that tailored elastic bandaging protocols can significantly reduce postural blood pressure drops and fall risk in surgical patients[7]. This study evaluates a novel bandaging technique designed to address gaps in current postoperative OH management.

METHODS

Study design and setting: A randomized clinical trial research design was utilized in the surgery departments at El-Demerdash University Hospital - Cairo March to June 2020. This study aimed to evaluate the preventive efficacy of a novel lower limb compression bandaging technique in reducing postural hypotension and its associated symptoms among postoperative major surgery patients during positional changes from lying to sitting position.

Study population: A consecutive sample of 60 patients undergoing major abdominal surgery was recruited from the study setting. The exclusion criteria included patients with previously diagnosed postural hypotension, hemodynamic instability, arterial insufficiency, legs edema or ulcers, impaired consciousness, or lack of cooperation, chronic renal failure, chronic obstructive airway disease, or malignancy. In addition, patients on medication that might induce postural hypotension were excluded. Subjects were randomly divided into two equal groups: a study group who had a bandage applied in their lower limbs, and a control group with no bandage of lower limbs.

Data collection: A patient assessment sheet was designed by the researcher to record patient data. It consisted of three parts. *Part I:* Patients demographic data such as age, and sex. *Part II:* Medical history such as reason for admission, and type of surgery whether elective or emergency. Patients were also asked about manifestations of postural hypotension such as dizziness (mild, moderate, severe), pallor, light-headiness, visual disturbances, impaired consciousness, palpitations, and syncope attacks. The number of hours staying in bed after surgery was also recorded. *Part III:* Physical assessment: included

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Table 1. Personal and diseases characteristics of patients in the study and control groups

Items	Study (n=30)		Control (n=30)		X^2	p-value
	No	%	No	%		
Age (years):						
<40	17	56.7	17	56.7		
40+	13	43.3	13	43.3		
Range	24.0-60.0		18.0-67.0			
mean±SD	37.5±8.9		36.6±12.1		0.34	0.74
Gender:						
Male	14	46.7	18	60.0		
Female	16	53.3	12	40.0	1.07	0.30
BMI:						
Normal (<25)	8	26.7	5	16.7		
Overweight/obese (25+)	22	73.3	25	83.3	0.88	0.35
Type of surgery:						
Emergency	8	26.7	8	26.7		
Elective	22	73.3	22	73.3	0.00	1.00
Bed recumbence (hours):						
<24	24	80.0	20	66.7		
24+	6	20.0	10	33.3	1.36	0.24

as measurement of weight and height. Blood pressure was measured in the lying and sitting positions. Heart rate, respiration rate, and oxygen saturation were also recorded[8].

Data collection procedure: The patient assessment sheet was filled by the researcher from the patient regarding demographic data, and from the medical file of the patient regarding medical history. The study group, compression bandages were applied along both legs that extend from the foot all the way up to the top of the thigh. They are designed to apply graduated, external pressure to the legs to assist venous and lymphatic return before sitting. The key principle is graduated compression:

- Highest pressure at the ankle.
- Gradually decreasing pressure up the leg.
- Lowest pressure at the thigh.

This pressure gradient acts as an "external muscle pump," helping to push blood and fluid upward against gravity towards the heart[5,8].

Baseline measurements were taken in the supine position prior to assuming the sitting position by applying the blood pressure cuff around patient upper arm and using the monitor to measure the vital signs. Oxygen saturation was also assessed by pulse oximeter. Patients were instructed to remain passive during the procedure. Then, the patients were seated and asked to dangle their feet. Vital signs, oxygen saturation, and associated manifestations of postural hypotension, if present, were recorded after 1, 3 and 5 minutes. As regards the control group, the same procedures were followed but without using the compression bandage.

Statistical Analysis: Data entry was done using Epi-Info 6.4 computer software package, while statistical analysis was done using SPSS 11 statistical software package. Data were presented using descriptive statistics in the form of frequencies and percentages for qualitative variables, and means and standard deviations for quantitative variables. Quantitative continuous data were compared using Student t-test in case of comparisons between two groups. When normal distribution of the data could not be assumed, the non-parametric Mann-Whitney test was used instead of Student t-test. Qualitative variables were compared using chi-square test. Whenever the expected values in one or more of the cells in a 2x2 tables was less than 5, Fisher exact test was used instead. Statistical significance was considered at p-value <0.05.

Ethical considerations: A written informed consent was obtained from patients in the surgical wards before the procedure. All patients were informed about the procedure and their rights, according to medical research ethics, and were free to decide whether they would participate in the study without any effect on their care. Then, written informed consents were obtained from patients who agreed to participate. This work has no conflicts of interest.

RESULTS

The personal and disease characteristics of patients in the study and control groups are shown in Table 1. It shows that the two groups were identical as regards the most important characteristics that might affect the occurrence of postural hypotension. Thus, it indicates no statistically significant differences in their age, gender, body mass index (BMI), as well as the type of surgery and length of bed recumbence.

Table 2. Hemodynamic signs and symptoms among patients in the study and control groups at various times in the lying and sitting positions

Variables	mean±SD		Mann-Whitney	p-value
	Study (n=30)	Control (n=30)		
Systolic BP (mm Hg)				
Baseline (lying)	120.33±13.5	115.0±13.1	2.31	0.13
1st min	104.5±14.8	99.0±12.8	2.03	0.15
3rd min	105.8±12.5	99.8±11.6	3.36	0.07
5th min	112.3±13.7	103.7±10.6	6.22	0.01*
Diastolic BP (mm Hg)				
Baseline (lying)	81.2±7.4	80.8±6.2	0.05	0.83
1st min	67.2±7.5	66.7±6.5	0.03	0.87
3rd min	70.5±8.3	67.3±7.0	2.07	0.15
5th min	74.2±7.0	70.2±6.9	4.10	0.04*
Heart rate (bpm)				
Baseline (lying)	80.6±3.9	82.5±1.3	2.00	0.16
1st min	83.7±4.4	88.6±5.5	12.29	<0.001*
3rd min	83.1±4.0	89.4±3.9	21.96	<0.001*
5th min	81.7±3.4	88.1±3.6	27.23	<0.001*
O_2 saturation				
Baseline (lying)	93.9±0.7	94.3±0.4	3.45	0.06
1st min	94.3±0.7	93.6±0.4	7.21	0.007*
3rd min	94.5±0.7	93.1±0.7	39.40	<0.001*
5th min	94.9±0.7	93.2±0.4	44.55	<0.001*
Palpitation (score: 1-3)				
Baseline (lying)	0.2±0.4	0.3±0.5	0.79	0.38
1st min	1.5±1.0	2.4±0.7	13.80	<0.001*
3rd min	0.7±0.8	1.6±0.5	19.96	<0.001*
5th min	0.3±0.5	1.2±0.6	23.88	<0.001*
Dizziness (score: 1-3)				
Baseline (lying)	0.2±0.4	0.4±0.5	1.43	0.16
1st min	2.1±0.8	2.8±0.4	14.86	<0.001*
3rd min	1.1±0.6	1.9±0.3	27.05	<0.001*
5th min	0.5±0.7	1.7±0.5	31.02	<0.001*

(*) Statistically significant at p<0.05

The various measurements done and clinical symptoms assessed among patients at the lying and sitting positions demonstrated in Table 2. It is evident that the two groups, study and control, were similar in all measurements and assessments in the lying down position. Thus, no statistically significant differences were detected in their baseline blood pressure, heart rate, oxygen saturation, or in the severity of palpitation and dizziness. Systolic and diastolic blood pressure in both groups decreased at the first minute of sitting but increased thereafter. At the fifth minute, the mean systolic and diastolic blood pressure were statistically significantly higher in the study group, p=0.01 and p=0.04 respectively, compared to the control group. As for the heart rate, and the severity of palpitations and dizziness, the means were statistically significantly lower in the study group, compared to the control group, at the first, third, and fifth minutes of the sitting position, p<0.001. Moreover, the mean value of oxygen saturation was statistically significantly higher in the study group, compared to the control group at all sitting times, p<0.001.

Concerning the occurrence of postural hypotension, Table 3 indicates that both systolic and diastolic postural hypotension were higher among patients in the control group, compared to the study group, at all sitting times. However, the difference reached statistical significance only at the fifth minute for diastolic postural hypotension, p=0.02.

Table 4 illustrates the changes from baseline lying position in various measurements done and hemodynamic symptoms and signs assessed among patients at various times of the sitting positions. It indicates decreases in the study and control in both systolic and diastolic blood pressures. However, the magnitude of the decrease was higher in the control group, and the difference was statistically significant at the fifth minute for diastolic blood pressure, p=0.03. The increases in heart rate, and in the severity of palpitation and dizziness were also higher among patients in the control group, compared to those in the study group, and the differences were statistically significant except for heart rate at the first minute, p=0.12.

Table 5 compares the signs and symptoms associated with postural hypotension in the study and control groups. It indicates that the incidences of symptoms of light-headedness, visual disturbances, and the pallor sign were statistically significantly higher among patients in the control group, compared to the study group patients, p<0.001. As for syncope, it occurred in a few patients in the two groups, with no statistically significant difference.

DISCUSSION

Postural or orthostatic hypotension often causes troublesome symptoms such as dizziness, syncope, and falling, thus interfering with active daily life or various therapies in rehabilitation. Non-pharmacologic measures for treating patients with postural hypotension include wearing elastic leotard compression, tilting head-up at night, etc. Elastic garment or antigravity suits is certainly effective, but it's bound on the lower limbs has been thought to be useful, and there are few clinical reports about its beneficial evidence[8]. Thus, we investigated short-term clinical effects of new elastic bandage on postural hypotension and its related signs and symptoms.

Table 3. Systolic and Diastolic postural hypotension among patients in the study and control groups at various times in the sitting position

Postural hypotension	Study (n=30)		Control (n=30)		X^2	p-value
	No	%	No	%		
Systolic (decrease of 20+ mm Hg)						
1st min	15	50.0	17	56.7	0.27	0.60
3rd min	10	33.3	10	33.3	0.00	1.00
5th min	3	10.0	7	23.3	1.92	0.17
Diastolic (decrease of 1 5+ mm Hg)						
1st min	16	53.3	17	56.7	0.07	0.80
3rd min	10	33.3	14	46.7	1.11	0.29
5th min	2	6.7	9	30.0	5.45	0.02*

(*) Statistically significant at p<0.05

Table 4. Changes in hemodynamic signs and symptoms, relative to lying down position, among patients in the study and control groups at various times in the sitting position

Differences from lying down values	mean±SD		Mann-Whitney	p-value
	Study (n=30)	Control (n=30)		
Systolic BP (mm Hg)				
1st min	-15.8±5.9	-16.0±6.6	0.03	0.86
3rd min	-14.5±7.5	-15.2±7.3	0.13	0.72
5th min	-8.0±7.5	-11.3±8.3	2.82	0.09
Diastolic BP (mm Hg)				
1st min	-14.0±4.6	-14.2±5.7	0.02	0.88
3rd min	-10.7±7.5	-13.5±6.5	2.02	0.16
5th min	-7.0±5.8	-10.7±6.8	4.68	0.03*
Heart rate (bpm)				
1st min	3.1±2.1	6.2±4.5	2.40	0.12
3rd min	2.4±1.6	6.9±3.1	30.10	<0.001*
5th min	1.1±1.7	5.7±2.7	32.91	<0.001*
O_2 saturation				
1st min	0.4±0.1	-0.7±0.2	44.99	<0.001*
3rd min	0.6±0.2	-1.2±0.7	44.45	<0.001*
5th min	0.9±0.3	-1.1±0.3	44.56	<0.001*
Palpitation (score: 1-3)				
1st min	1.3±0.9	2.1±0.8	14.49	<0.001*
3rd min	0.5±0.7	1.3±0.6	19.15	<0.001*
5th min	0.1±0.5	0.9±0.7	20.19	<0.001*
Dizziness (score: 1-3)				
1st min	1.9±0.7	2.4±0.5	9.79	0.002*
3rd min	1.0±0.6	1.6±0.5	15.15	<0.001*
5th min	0.3±0.5	1.4±0.6	26.90	<0.001*

(*) Statistically significant at p<0.05

Table 5. Comparison of clinical signs and symptoms among patients in the study and control groups

Items	Study (n=30)		Control (n=30)		X^2	p-value
	No	%	No	%		
Pallor:						
Absent	17	56.7	0	0.0		
Present	13	43.3	30	100.0	23.72	<0.001*
Light headedness:						
Absent	16	53.3	0	0.0		
Present	14	46.7	30	100.0	21.82	<0.001*
Visual disturbance:						
Absent	21	70.0	5	16.7		
Present	9	30.0	25	83.3	17.38	<0.001*
Syncope:						
Absent	27	90.0	23	76.7		
Present	3	10.0	7	23.3	1.92	0.17

(*) Statistically significant at p<0.05

The current study revealed that overall, about half of the patients in the study and control groups had postoperative postural hypotension at the first minute of sitting. At the fifth minute, only less than ten percent of patients in the study group, with bandage, had postural hypotension, compared to about one third of those in the control group, and the difference was statistically significant. Leg bandaging has no preventive effect on classical postural hypotension and found it similarly prevalent in the bandaged and unbandaged state[9].

Concerning postural hypotension associated signs and symptoms, the present study has shown statistically significant improvements in the study group, compared to control group during the first, third, and fifth minutes after changing position from lying to sitting position. As regards heart rate, there was a slight increase in the bandaged group, compared to larger increases in the control group, and the differences were statistically significant. Moreover, multivariate analysis has revealed that the intervention (application of bandage) was a statistically significant independent predictor of lower increase in heart rate. Meanwhile, the heart rate was negatively correlated to both systolic and diastolic blood pressure as well as oxygen saturation and positively correlated to severity of dizziness and palpitation. This means that in the bandaged state, heart rate remained relatively stable, with lower incidence of postural hypotension, and the reverse occurred in the control group[10].

According to the present study results, statistically significant differences were revealed between the study and control groups as regards oxygen saturation. In the control group patients, not wearing compression bandages, oxygen saturation decreased, while in those with compression bandage, it increased over time during the first, third, and fifth minutes after changing position from lying to sitting position. In further confirmation, multivariate analysis has revealed that the intervention (application of bandage) was a statistically significant independent predictor of increased oxygen saturation and explained 94% of this increase[11]. Meanwhile, oxygen saturation was negatively correlated to heart rate and to the severity of dizziness and palpitation and positively correlated to both systolic and diastolic blood pressure. This means that in the study group who had bandage, oxygen saturation was stable or even improved, while in patients without bandage, significant decreases are demonstrated. Therefore, these study patients had lower effects of postural hypotension in the form of lower severity of palpitations and dizziness, compared to the control group[12].

In confirmation, multivariate analysis revealed that the intervention of bandaging was a statistically significant independent negative predictor of the severity of palpitation. Moreover, the severity of palpitation was negatively correlated to oxygen saturation and positively correlated to the heart rate and the severity of dizziness. Therefore, increased heart rate, associated with postural hypotension, would lead to more severity of the sensation of palpitation, which might also be related to decreased oxygen saturation[13].

The severity of dizziness was positively correlated to heart rate and severity of palpitation and negatively correlated to oxygen saturation and systolic and diastolic blood pressure (r=-0.33). This means that the application of the bandage in the study group had a beneficial effect on the severity of the postural hypotension associated symptom of dizziness[14].

Furthermore, the symptoms of light-headedness, visual disturbances, and the pallor sign in the present study were found to be statistically significantly more common among patients in the control group, compared to the study group patients. The symptoms that often accompany orthostatic hypotension include dizziness, faintness, and light-headedness, which appear during sudden change of position[15].

The present study has also shown that obesity was a statistically significant independent predictor of diastolic blood pressure, heart rate, and severity of dizziness. It had an increasing effect on diastolic blood pressure, and a decreasing effect on heart rate and severity of dizziness. Age was also a statistically significant independent predictor of increased heart rate. As for gender, although female gender was associated with less increases in the heart rate, it was associated more severity of sensation of palpitation and dizziness[16].

Implications of the Study:
The integration of Dynamic Compression Therapy into nursing practice and health care policy has the potential to significantly improve postoperative outcomes by reducing postural hypotension. By standardizing guidelines, enhancing nursing education, and ensuring policy support, health care systems can adopt DCT as a safe, effective, and cost-efficient intervention in postoperative care. The use of elastic bandages is advisable when seating patients post-operatively, especially with major surgery and long bed recumbence. Further trials are recommended, assessing the use of stockings or inflatable boots. Longer follow-up studies are suggested to assess the long-term effect on postural hypotension, and the possible side-effects of the interventions.

CONCLUSION

Hemodynamically significant postural hypotension is common among patients when seated following even a short-term bed rest post-operatively. The potentially serious consequences may be largely prevented by prior leg bandaging. The use of elastic bandage in each patient and the inclusion of objective parameters, such as heart rate and oxygen saturation, lend support to the reliability of both the methodology and the results.

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