Original Article

The Effect of Different Mechanical Prevention Methods on Risk of Venous Thromboembolism in Trauma Patients: A Randomized Controlled Trial

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Abstract
Aim: This study was conducted to determine the effect of different mechanical prevention methods used in trauma patients' risk of venous thromboembolism (VTE).
Methods: The sample of this randomized controlled clinical study consisted of 42 patients who were hospitalized due to trauma in the Intensive Care Unit (ICU). In the study, intermittent pneumatic compression devices (IPC) were applied to one of the groups, group (n=21) while anti-embolism stockings (AES) were applied to the other group (n=21) for seven days beginning from the first day of their stay in the ICU. In order to determine patients' risk of VTE, Wells score, D-dimer and arterial blood gas [partial oxygen pressure (PaO_2), partial carbon dioxide pressure ($PaCO_2$)] were measured before the application and on the 1st, 3rd and 7th days of the application.
Results: Before the application of IPC or AES and on the before, after 1st, 3rd and 7th days of the application, all patients were found to have low and moderate risk of VTE risk according to the Wells scores and no patients were classified as high risk. There was no significant difference between the Wells scores, D-dimer and $PaCO_2$ of the patients who were received IPC and AES were compared at the time points ($p>0.05$). However, the PaO_2 mean of the IPC patients on the 1st day of the application and the PaO_2 mean of the AES patients before the application were significantly higher than their means on the 7th day following the application ($p<0.05$). Nevertheless, no significant difference was found between the PaO_2 means of the IPC and AES patients ($p>0.05$).
Conclusion: This study showed that mechanical prevention methods such as AES and IPC applied by nurses in the early period beginning from ICU hospitalization in trauma patients with low and moderate VTE risk prevented VTE development.

Key words: Venous thromboembolism, trauma, anti-embolism stockings, intermittent pneumatic compression devices, nurse, intensive care unit.

Introduction

Venous thromboembolism (VTE) is a common and life-threatening complication that has a 5-63% occurrence rate in trauma patients (Muramoto 2017; Paydar et al. 2016; Rappold et al., 2021). VTE has important clinical consequences such as increased length of intensive care unit (ICU) and hospital stay, disability and even suddenly death. And VTE may increase substantial healthcare direct cost (include medication, physician and other personnel costs, diagnostic radiology and laboratory testing, operative and non-operative procedures, costs associated with bleeding, transfusions and treatment-related complications) and indirect costs (include ICU and hospital ward overhead costs) (Fowler et al., 2014; Gao et al., 2022). The risk of VTE is particularly high in patients with pelvic and lower extremity fractures or head trauma (Paydar et al., 2016). While the incidence of DVT with head trauma is 54% without prophylaxis, this rate is reduced to 20% through the use of intermittent pneumatic compression devices (IPC) (Rappold et al., 2021). Although no method is completely effective in preventing VTE, morbidity and mortality rates due to VTE increase significantly when prevention methods are not used (Lawrance, Good, Carlson 2009). Methods used to prevent VTE are pharmacologic prophylaxis (low-dose heparin, low molecular weight heparin, oral anticoagulants, etc.), mechanical prophylaxis [anti-embolism stockings (AES), IPC, etc.] and venous filters (Paydar et al., 2016).

The risk of thrombosis is present in trauma patients within 24 hours after injury. This risk is most pronounced approximately 5 days after injury, before beginning to decrease 14 days after injury (Zeng & Wu 2023). Therefore, if there is no contraindication, the use of pharmacologic agents is recommended 48 - 72 hours after trauma (Glassner et al., 2013; Haddad et al., 2012; Hamada et al., 2017; Nyquist et al., 2016). As early mobilization is not possible in trauma patients due to injuries, anticoagulants may increase the risk of bleeding at the wound site (Gomes et al., 2020). Moreover, in trauma patients hospitalized in an intensive care unit (ICU), the risk of VTE doubles during this 48 – 72-hour period and then triples after 96 hours (Markovic et al., 2018). The requirement of late onset of pharmacologic prophylaxis due to the risk of bleeding, and the lack of consistent evidence in the guidelines (Witt et al., 2018), suggests that mechanical methods, such as IPC and AES (Amer et al., 2023; Gomes et al., 2020; Zeng et al., 2023), be used with patients who are at a high risk of VTE.

The use of AES prevents venous stasis by compressing the diameter of vessels. When properly dressed, the AES creates external pressure that prevents venous blood from pooling in the extremities. This supports venous return by applying continuous pressure, as is the case with leg muscles (Akyüz & Tunçbilek 2018; Onwuzo et al., 2023). There is no recommendation in the literature on how many hours a day AES should be used to prevent DVT in inpatients. However, in a study conducted with 20 volunteers, it was reported that the use of 20-30mmHg pressure elastic stockings for 10 hours/day was beneficial in reducing edema (Lattimer et al., 2013). It has been reported that high-pressure stockings can cause skin damage in trauma patients, while medium-pressure stockings of 18mmHg at the ankle and 8mmHg at the hip are effective in preventing the development of VTE (Caprini 2010). In addition, AES extending to the hip are more effective in preventing DVT than the form which only extends to the knee (Caprini 2010; Nickles et al., 2023). In order for AES to be effective, it is necessary to choose appropriately sized socks for each individual (Akyuz & Tuncbilek 2018).

The IPC consists of a fabric sheath with a pump attached which is worn on the patient's leg. The device provides a periodic delivery of pumped air, and this pumping of air ensures that the deep venous systems are compressed, and the blood is displaced proximally. When the cuff deflates, the vessels refill distally, stimulating the flow of blood and maintaining pulsation. The stimulating effect of the fibrinolytic activity in the venous walls also helps to reduce VTE by lowering the plasminogen activator inhibitor level (Onwuzo et al., 2023; Vignon et al., 2013; Weinberg et al. 2016). This use of IPC simulates patient mobility, thus increasing venous return, promoting fibrinolysis, and preventing VTE by providing contraction and relaxation of the muscles (Zeng & Wu 2023). Although the literature does not recommend how many hours a day IPC should be used to prevent DVT in hospitalized patients (Serin et al., 2010), it has been reported that IPC is effective in fibrinolysis when administered for two hours a day. In the past study, it was reported that IPC increased endogenous fibrinolysis, tissue factor inhibitor and plasminogen activator when applied for 2 hours (Arabi et al., 2016).

In trauma patients, the nurse is responsible for continuous individual risk assessment during the hospital stay, which involves checking for symptoms of VTE, encouraging the patient in early mobilization and leg exercises, ensuring the use of IPC and AES, and monitoring the patient for any bleeding complications when pharmacological methods are applied (Akyuz

& Tuncbilek 2018; Gomes et al., 2020; Zeng & Wu 2023).

There is still controversy about the definitive method of VTE prophylaxis in trauma patients, and large randomized prospective clinical trials are needed to provide level I evidence to optimally define VTE prophylaxis in trauma patients (Paydar et al. 2016). Although pharmacologic methods for the prevention of VTE may be part of the preventative care for trauma patients in the ICU setting, there is still a high risk of bleeding. Pharmacologic methods could not be applied to trauma patients in the ICUs where the study was conducted. Previous research has generally focused on the detection (Ljungqvist et al., 2008) and prevention (Fuji et al., 2016) of deep vein thrombosis (DVT), and ultrasonography (USG) has often been used to detect DVT (Patel et al., 2020). However, ultrasound devices were not used for DVT detection in the ICU where the study was conducted and also routine ultrasound screening for DVT is not a cost-effective diagnostic strategy in practice (Fowler et al., 2014), and the risk of VTE was assessed by arterial blood gas (ABG) [partial oxygen pressure (PaO_2); partial carbon dioxide pressure ($PaCO_2$)] and the D-dimer test. In this study, the effect of IPC and AES on the prevention of VTE development in trauma patients was determined by using routinely performed tests (ABG, D-dimer) in the ICU.

Methods

Study Hypotheses: H_0: There are no differences in Wells score, D-dimer results and ABG (PaO_2, $PaCO_2$) values between patients receiving IPC or AES.

H_1: There are differences in Wells score, D-dimer results and ABG (PaO_2, $PaCO_2$) values between patients receiving IPC or AES.

Study Design: This prospective, two-arm (1:1), randomized controlled clinical study was conducted to determine the effect of the use of different mechanical methods in reducing the risk of VTE development in trauma patients hospitalized in the ICU.

Sample and Setting and Data Collection: The study population consisted of 81 patients hospitalized due to trauma in the Anesthesiology and Reanimation ICU of Mersin University Hospital, Türkiye, between May 2017 and September 2018. The University Hospital is a community-based hospital providing 3rd level health services and has 145 intensive care beds and a total of 860 beds. In the intensive care unit where the research was conducted, there are 11 patient beds and follow-up, treatment and care of patients with respiratory distress, trauma (vehicle traffic accidents, head trauma, chest trauma, multiple trauma, etc.), postoperative patients such as neurosurgery, general surgery, thoracic surgery and internal patients such as neurology, infection, intoxications are carried out. The trauma patients included in the sample were 18 years of age or older, had an arterial catheter, did not have lung disease (chronic obstructive pulmonary disease, lung cancer, chest trauma, etc.), and had written and verbal consent from themselves/relatives to participate in the study. The following were all reasons for patients to be excluded from the study: A condition that prevented the use of IPC and AES (chronic superficial or deep venous insufficiency, venous anomaly, a previous history of VTE, anticoagulant therapy, open fracture, extensive dermatitis in the lower legs, a history of thrombophilia, being pregnant, or a complicated pelvic fracture and spinal cord injury), having been transferred from a different ICU/clinic, having relatives who refused permission for participation in the study, or being younger than 18 years.

The sample was calculated using a study by Ljungqvist et al. (2008) as a reference point. A difference of 0.75 standard deviation was observed between groups with 5% Type I error and 80% power, in which a change of 0.75 standard deviation for Wells score and D-dimer variables in trauma patients was considered as being clinically significant. Sample size was calculated with a minimum of 28 patients in each group. During the study period, 81 patients were hospitalized in the ICU, but patients with fractures in the lower leg (n=22), as well as patients who refused to participate (n=3), were not included in the study. While the study included 56 patients, those who died during the study period (n=7) or were transferred to the ICU/service before the end of the seven-day intervention (n=9), were excluded from the study and not included in the data analysis. A total of 42 patients therefore participated in the study.

The CONSORT flowchart of the study is shown in Figure 1.

Randomization and Group Allocation: Patients were allocated to the IPC and AES groups by block randomization (1:1). Group A (IPC) and Group B (AES) were determined by the simple random sampling such as lottery method. The coordinating researcher (GAU) wrote the number of the sample (n=56) on a series of envelopes. Inside the envelopes, information on whether the participant was in the IPC or the AES group was written according to the number. The envelopes were then sealed and kept by the coordinating researcher (GAU). When the patient was admitted to the ICU due to trauma, the researcher (DA) assessed the patient's compliance with the research criteria. When the researcher (DA) visited the patient, she opened the envelope and learned which group the patient was in. After the research had been completed, the data was computerized by a statistician who was unfamiliar with Groups A and B. An independent statistician analyzed the data and reported the findings. This procedure ensured that the data analysis and statistics phases were also blinded to group allocation.

Data Collection Forms: Data was collected between May 2017 and September 2018 using the "Descriptive and Clinical Characteristics Form" and the "Venous Thromboembolism Risk Assessment Form" prepared by the researchers.

The Descriptive and Clinical Characteristics Form consists of five questions regarding the patient's age, gender, body mass index (BMI), diagnosis and the length of the stay in the ICU.

The Venous Thromboembolism Risk Assessment Form consists of a chart in which the Wells score, D-dimer, and ABG values were recorded before IPC or AES application, the day of application, and then 1, 3 and 7 days after application.

The Wells Score is a clinically proven scoring system used to determine the probability of DVT before the test. Its purpose is to increase the diagnostic accuracy rate in the diagnosis of acute pulmonary embolism (PE) and to prevent unnecessary tests (Stone et al. 2017). The Wells score measures the probability of the occurrence of DVT: A score below 2 points indicates a low probability, a score between 2-6 points indicates a moderate probability, and a score above 6 points indicates a high probability (Wells et al., 2001).

The D-dimer Test measures the amount of substance produced in the breakdown of fibrin, which is the body's fibrinolytic response to thrombus formation (Cohen et al., 2014; Karalezi et al., 2018; Riley et al., 2016; Wall et al., 2016). A D-dimer test result of more than 500 mg/dl indicates a high risk of VTE, whereas a result of less than 500 mg/dl indicates a low risk of VTE (Karamat et al., 2017; Riley et al., 2016). However, since D-dimer test results are known to be high in trauma patients (Arseven et al. 2015; Kanan et al., 2020; Lewis et al., 2018), a D-dimer cut-off value of 15 µg/ml (7500ng/ml) was taken in this study as a reference point for the past study in which new screening criteria for VTE in trauma patients were determined (Iyama et al., 2018).

Arterial Blood Gas occurs when PE develops on ABG showing a decrease in respiratory functions PaO_2 and an increase in $PaCO_2$ (Skrifvars et al., 2017). PaO_2>80mmHg, $PaCO_2$>36mmHg, and a respiratory rate of <20 times per minute, indicate no PE development (Cohen et al. 2014; Subramanian et al., 2018; Vignon et al., 2013).

Procedures: Trauma patients admitted to the ICU were randomly divided into IPC and AES groups.

The Intermittent Pneumatic Compression Devices Group: Patients hospitalized in the ICU were administered IPC for seven days after admission. IPC was accordingly administered 3 times a day for 2 hours, and the patient rested for 2 hours between each application. The IPC used in the study consists of an air pump, a limb cuff and connection cables. Plastic cuffs wrapping the leg inflate and deflate to support venous return by using alternating amounts of pressure against the extremity. In the study, an IPC device (Kendall SC, 2000 TYCO, UK) was used with a calf compression pressure of 40mmHg, which is recommended to reduce the risk of VTE (Nickles et al., 2023).

The Anti-Embolism Stockings Group: Patients hospitalized in the ICU wore AES for 10 hours a day during seven days after admission. The AES used in the study was of a size determined according to the patient's BMI, applied moderate pressure, and extended to the hip. The Wells score, the D-dimer level and ABG (PaO_2, $PaCO_2$) were measured before and on the 1st, 3rd and 7th days of ICP/AES application. All of the data was recorded on the Venous Thromboembolism Risk Assessment form.

Arterial blood gas was measured by taking a blood sample in the ICU from the patient's arterial catheter and using a blood gas meter (Radiometer ABL800, Radiometer Medical Aps, Copenhagen). The blood sample taken for the D-dimer test, which is routinely followed in all trauma patients hospitalized in the ICU where the study was conducted (7pm every evening), was measured in the biochemistry laboratory of the hospital. The Wells score of the patients was also evaluated and recorded by the researcher in the evening when the blood samples were taken.

Statistical Analysis: Descriptive data was expressed in terms of frequency, percentage, mean and standard deviation. The chi-square test was used to compare categorical variables. The data was analyzed using parametric tests, without the normality test, due to their compliance with the Central Limit Theorem (Norman et al., 2010). An independent t-test was used to compare two independent groups, and analysis of variance (ANOVA) was used for repeated measurements. The Bonferroni-Dunn test was used for multiple comparison analyses (post hoc) between groups as further analysis. In the data analysis of this study, the statistical significance level was set at $p < 0.05$.

Ethical Considerations: The study was approved by the Ethics Committee (Date: 11.05.2017, No: 2017/148), and permission was granted by the clinic in which the research was conducted (Date: 12.05.2017, No: 78017789/050.01.04/417710). Written and verbal consent was obtained from all the patients' relatives.

Results

Table 1 shows the descriptive and clinical characteristics of the patients. The mean age was 51.3±22.9 years in the IPC group and 40.1±17.2 years in the AES group. The BMI of the IPC group was 25.4±3.3 and that of the AES group was 25.4±3.6. The duration of ICU stay in the IPC group was 11.0±4.9 days, while the duration of ICU stay in the AES group was 22.9±28.3 days. 95.2% of the IPC group and 57.1% of the AES group were male; 71.4% of the IPC group and 52.4% of the AES group were hospitalized in the ICU due to multiple organ trauma. There was no significant difference between the groups in terms of descriptive and clinical characteristics (age, BMI, length of stay in the ICU, and diagnosis), apart from gender ($p>0.05$). All the groups were homogeneous in terms of the characteristics reported, although there were more male than female patients in both groups ($p<0.05$) (Table 1).

According to Wells scores, patients in both groups had a low risk of VTE. There was no significant difference according to time ($p>0.05$) in the mean Wells score and D-dimer values of patients who applied IPC and AES. When the Wells scores and D-dimer values of the ICP and AES groups were compared on before and 1st, 3rd, 7th days of IPC/AES application, no significant difference was found between them ($p>0.05$) (Table 2, Table 3).

It was found that the mean PaO_2 in patients using IPC on the 1st day of application was significantly higher than on the 7th day of application ($p=0.03$), and the mean PaO_2 before application in patients using AES ($p=0.001$) was significantly higher than on the 7th day after application. When the ABG values (PaO_2, $PaCO_2$) of the IPC and AES groups were compared on before and 1st, 3rd, 7th days of IPC/AES application, no significant differences was found between them ($p>0.05$) (Table 4). These results showed that H_0, the hypothesis of no difference in Wells score, D-dimer results and ABG (PaO_2, $PaCO_2$) values between patients receiving IPC or AES, was accepted.

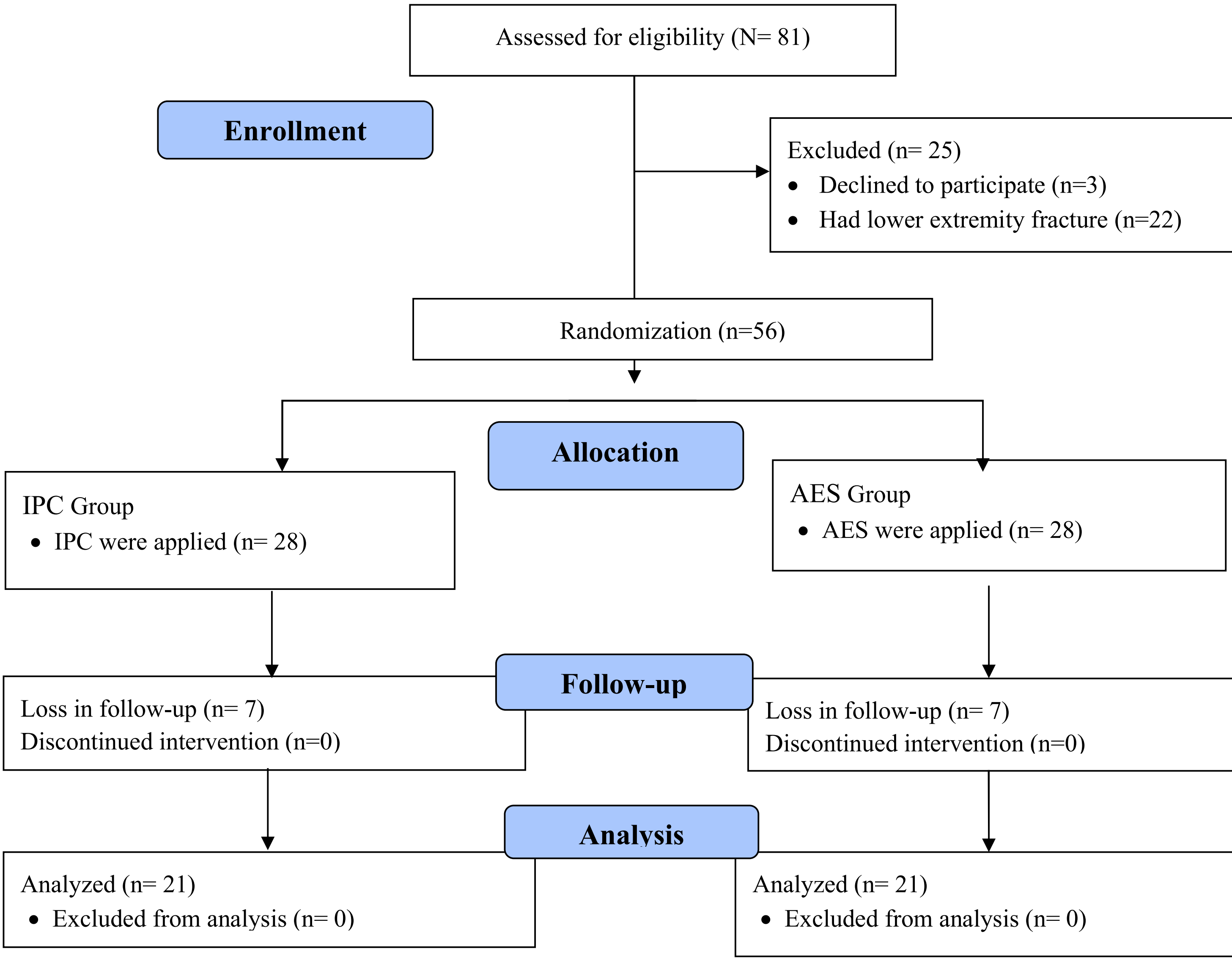

Figure 1. CONSORT flowchart of the research

Table 1. Descriptive and Clinical Characteristics of Patients (n=42)

Characteristics	IPC group (n=21)		AES group (n=21)		Test	p
	x̄±SD		x̄±SD			
Age	51.3±22.9		40.1±17.2		-1.797€	0.08
Body Mass Index	25.4±3.3		25.4±3.6		0.029€	0.98
Length of stay in the ICU	11.0±4.9		22.9±28.3		1.896€	0.07
Gender	**n**	**%**	**n**	**%**	8.400¥	**0.004**
Women	1	4.8	9	42.9		
Men	20	95.2	12	57.1		
Diagnosis						
Head trauma	6	28.6	10	47.6	1.615¥	0.20
Multiple organ trauma	15	71.4	11	52.4		

€ Dependent sample t-test. ¥ Chi-square test.
IPC: Intermittent pneumatic compression devices AES: Anti-embolism stockings SD: Standard deviation ICU: Intensive care unit

Table 2. Comparison of Patients' Wells Scores (n=42)

Wells Score Evaluating Times	IPC group (n=21)	AES group (n=21)	Test€	p
	x̄±SD	x̄±SD		
Before the application	1.8±1.0	2.0±1.1	-0.518	0.61
1st day of the application	1.6±1.3	1.9±1.0	-1.065	0.29
3rd day of the application	1.8±0.7	1.7±0.5	0.602	0.55
7th day of the application	2.0±0.8	1.7±0.5	1.113	0.27
Test ©	1.106	1.199		
p	0.34	0.32		

€ Dependent sample t-test. © Repeated measures analysis of variance (ANOVA)
IPC: Intermittent pneumatic compression devices AES: Anti-embolism stockings SD: Standard deviation

Table 3. Comparison of Patients' D-dimer Values (n=42)

D-dimer Testing Times	IPC group (n=21)	AES group (n=21)	Test€	p
	x̄±SD	x̄±SD		
Before the application	8409.0±5338.1	6361.5±8843.0	0.908	0.37
1st day of the application	7320.7±5992.0	7505.5±12537.3	-0.061	0.95
3rd day of the application	9733.7±19268.5	4826.7±7079.9	1.095	0.33
7th day of the application	7347.1±10897.5	6343.5±8620.9	0.280	0.74
Test ©	1.369	0.471		
p	0.27	0.76		

€ Dependent sample t-test. © Repeated measures analysis of variance (ANOVA)
IPC: Intermittent pneumatic compression devices AES: Anti-embolism stockings SD: Standard deviation

Table 4. Comparison of Patients' Arteriyel Blood Gas Values (n=42)

Arteriyel Blood Gas Values Testing Times	IPC group (n=21)	AES group (n=21)	Test€	p
PaO_2	x̄±SD	x̄±SD		
Before the application [a]	108.3±31.0	125.9±27.6	-1.943	0.06

1st day of the application[b]	109.9±35.9	113.8±29.3	-0.383	0.70
3rd day of the application[c]	96.8±28.8	102.8±31.0	-0.650	0.52
7th day of the application[d]	94.7±27.5	101.6±28.5	-0.804	0.43
Test ©	2.769	6.618		
p	**0.03**	**0.001**		
Significant*	b>d	a>d		
$PaCO_2$				
Before the application[a]	38.5±6.6	34.9±6.2	1.818	0.08
1st day of the application[b]	36.2±5.3	35.7±6.4	0.295	0.77
3rd day of the application[c]	37.7±7.6	35.9±6.4	0.862	0.39
7th day of the application[d]	40.0±9.4	35.0±7.8	1.867	0.07
Test ©	1.262	0.184		
p	0.30	0.95		

€ Dependent sample t-test. © Repeated measures analysis of variance (ANOVA) *Bonferroni-Dunn test
IPC: Intermittent pneumatic compression devices AES: Anti-embolism stockings SD: Standard deviation PaO_2: Partial oxygen pressure $PaCO_2$: Partial carbon dioxide pressure

Discussion

The current study demonstrates how two different mechanical preventive methods, applied from the time of ICU admission to trauma patients, reduced this population's previously high risk of VTE. It was also found from comparison that there was no superiority in the Wells score, D-dimer, or the $PaCO_2$ averages of patients enrolled in either the IPC or AES arm of the study.

The effect of mechanical preventive methods on the risk of DVT development: A D-dimer test of more than 500 ng/ml indicates a high risk of DVT in the patient (Arseven et al. 2015; Riley et al. 2016; Schutte et al. 2016). In studies utilizing new screening criteria, including D-dimer test, to assess for the early diagnosis of VTE in trauma patients, the cut-off value of D-dimer was determined as being 15 µg/ml (7500ng/ml) in patients who developed VTE (Iyama et al. 2018).

All patients in the study had a low to moderate risk of developing a DVT (Table 2), according to the Wells score. The patient's D-dimer levels were lower than the reference range and did not reflect previous studies where this test was expected to be elevated in trauma patients (Cohen et al., 2014; Iyama et al., 2018; Peng et al. 2017; Schutte et al., 2017).

The D-dimer test was found to be below the upper limit value referenced by Iyama et al., (2018) for seven days, although it increased at different times after ICU admission in all patients. These results showed that IPC and AES applied to patients reduced the risk of DVT within the first seven days.

The incidence of DVT in trauma patients increases relative to the Wells score (Haren et al., 2014). In a previous study, patients hospitalized in the ICU were monitored for 14 days and the incidence of DVT was found to be 4.4% in patients with a Wells score of ≤3 who applied IPC (Wan et al., 2015). In this study, unlike a previous study (Wan et al., 2015), the mean Wells score of the patients was <3 and DVT was monitored for only 7 days. This may be the reason why none of the patients in this study who underwent IPC/AES developed DVT. The risk of developing VTE increases with the length of ICU hospitalization.

In a previous study, conducted with 798 patients hospitalized in the ICU (Arabi et al. 2013), VTE developed in 4.8% of patients who underwent IPC, 10% of patients who underwent AES, and 7.2% of patients who did not use mechanical preventive methods.

As a result of this study, it was reported that IPC significantly reduced the risk of VTE, although AES did not. In this study, unlike the study by Arabi et al., (2013) none of the patients developed VTE and IPC, and AES showed similar effects in preventing the development of VTE. This difference may be due to the fact that Arabi et al., selected their sample from non-traumatized patients hospitalized in the ICU and applied both pharmacologic agents and mechanical methods.

The effect of mechanical preventive methods on the risk of PE development: The aim of VTE prophylaxis in trauma patients is not only to prevent DVT, but also to reduce mortality from PE. Reducing the incidence of DVT means decreasing the incidence of PE (Pernod et al., 2017). While false negative diagnosis in PE can lead to fatal outcomes (Pernod et al., 2017, Yamamoto 2018), false positive diagnosis can lead to unnecessary use of anticoagulants and needless exposure of patients to radiation for diagnostic purposes (Pernod et al., 2017). The ideally recommended way of diagnosing PE is to classify patients clinically (Wells score, etc.), exclude the diagnosis of PE with D-dimer test in patients with low and moderate risk scores, and evaluate the patient with imaging methods in patients with high-risk scores (Geersing et al., 2014; Pernod et al., 2017). PE can be excluded 97% of the time with D-dimer result in low-risk patients according to the Wells score (Young et al. 2013). In addition to the tests, since hypoxemia develops in 98% of patients with PE, ABG analysis helps to diagnose PE (Dhananjaya, Kirankumar, Rajendrakumar 2018; Tank, Dave, Damor 2018). In this study, Wells score, D-dimer test and ABG were used in the diagnosis of PE. While PaO_2 was >80mmHg in both mechanical preventive methods, $PaCO_2$ was only <36mmHg in patients who underwent AES. However, the fact that there was no difference in $PaCO_2$ values between both groups, and that none of the patients were diagnosed with PE, suggested that this result was not clinically significant.

It is important to begin VTE prophylaxis early as pulmonary embolism usually occurs 3-4 days after trauma (Bahloul et al., 2018). PEs can develop within 3-7 days after DVT and can cause 10% mortality within one hour of the onset of symptoms (Morrone et al., 2018). This study showed that if mechanical prophylaxis is started early in patients it can prevent PE, even if pharmacologic agents are not used.

Limitations: One of the limitations of this study is that radiologic diagnostic methods, such as Doppler USG for DVT and computed tomography for PE, were not used to determine the risk of VTE in the study. Because these methods are not routinely used in the ICU where the study was conducted and also routine ultrasound screening for DVT is not a cost-effective diagnostic strategy in practice (Fowler et al., 2014). Another limitation is the fact that autopsies were not performed on patients who had died in the ICU during the research conducted. Although the cause of death of the patients who died was not associated with VTE in this study, it is possible that the cause of death was PE. Another limitation of the study is that, for several reasons, it was not possible to achieve the calculated sample size. It would therefore be advantageous to repeat the study with a larger sample group. Another limitation is the lack of generalizability of the results to other clinical sites globally.

Conclusion: In conclusion, VTE, which is common in trauma patients in the ICU, leads to worsening of the prognosis of patients and may cause negative effects such as prolonged ICU stay and increased financial burden on healthcare systems. Therefore, it is important to prevent it before it occurs. This study showed that mechanical prevention methods such as AES and IPC applied by nurses in the early period beginning from ICU hospitalization in trauma patients with low and moderate VTE risk prevented VTE development.

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