

Comparison of Knee-High and Thigh-High Graduated Compression Stockings in Preventing Deep Vein Thrombosis in Patients with Hemorrhagic Stroke

Ehsan Azami,¹ Masoumeh Abedzadeh-Kalahroudi,^{2,*} Mansour Dianati,¹ and Zohreh Sadat²

¹Medical Surgical Nursing Department, Faculty of Nursing and Midwifery, Kashan University of Medical Sciences, Kashan, IR Iran

²Trauma Nursing Research Center, Kashan University of Medical Sciences, Kashan, IR Iran

*Corresponding author: Masoumeh Abedzadeh-Kalahroudi, Trauma Nursing Research Center, Kashan University of Medical Sciences, Kashan, IR Iran, E-mail: abedzadeh@kaums.ac.ir

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Abstract

Background: Deep Vein Thrombosis (DVT) is a common complication in patients with hemorrhagic stroke. Prophylaxis and treatment of DVT in these patients is very difficult because there are some limitations regarding the use of anticoagulant drugs.

Objectives: The purpose of this study was to compare the effectiveness of knee-high and thigh-high graduated compression stockings in preventing DVT in patients with hemorrhagic stroke.

Methods: In this clinical trial, 88 patients with hemorrhagic stroke were randomly assigned to two groups to receive either thigh-high or knee-high graduated compression stockings as prophylaxis for DVT. The prevalence of DVT was studied using clinical symptoms and Doppler ultrasound. Chi-square and Mann Whitney U tests were used to analyze the data.

Results: In the thigh-high stockings group, 11 patients (26.8%) and in the knee-high stockings group, 18 patients (38.3%) were affected by DVT during the study. However, no significant difference was observed between the two groups ($P = 0.25$).

Conclusions: There was no significant difference between the two groups in the incidence of DVT. Therefore, either knee-high or thigh-high stockings can be used as prophylaxis, depending on patients' will, cost and ease of use.

Keywords: Stroke, Deep Vein Thrombosis, Graduated Compression Stockings

1. Background

Deep Vein Thrombosis (DVT) is a serious complication in patients with movement disorders, especially in those with cerebral vascular accident (CVA). Muscle weakness, paralysis of the lower limbs and DVT are common in patients with CVA (1). According to the Virchow's triad, the predisposing factors for DVT include: venous blood stasis, damages to the venous endothelium, and altered blood coagulation (2). All patients with CVA are at risk of DVT and pulmonary embolism so that 40% of them experience DVT in the first three weeks of the disease. About 18% of the DVTs occur in areas above the knees (3). Additionally, symptomatic pulmonary embolism occurs in 1% - 16% of patients with CVA, who have developed DVT (4). Deep Vein Thrombosis and pulmonary embolism are amongst the main causes of mortality and morbidity in these patients (5).

The methods for prevention of DVT are generally divided to two groups: mechanical and drug prevention. The most important mechanical interventions include: anti-thrombosis compression stockings, intermittent compression devices and physiotherapy. Drug interventions included the use of heparin, enoxaparin and war-

farin. The low risk, ease of use and low cost are the most important factors in selecting one of the methods. Based on these factors, the use of mechanical prophylaxis is more common (6, 7). Due to the risk of development or exacerbation of intracranial bleeding, chemoprophylaxis is not recommended for patients with stroke and especially in hemorrhagic stroke. For this reason, the current guidelines do not recommend the use of anticoagulants in these patients for the prevention of DVT. However, they emphasize on mechanical prophylaxis especially the use of compression stockings (8-16).

Anti-thrombosis compression stockings prevent DVT by reducing venous stagnation and increasing blood flow in the legs. They also improve the patients' quality of life by improving the performance of venous valves, increasing the speed of venous drainage, controlling edema and reducing symptoms in the legs (5, 12-15). These stockings are categorized into thigh-high and knee-high graduated compression stockings. Currently, there is much controversy for selecting one of these types of anti-thrombosis stockings in patients with hemorrhagic stroke. Knee-high stockings are less expensive and more comfortable than thigh-high stockings (16). However, some studies recom-

mend the use of thigh-high stockings for the prevention of DVT, because they completely cover the legs (17, 18). Currently, there is little data comparing between the impacts of these two types of compression stockings in the prevention of DVT in patients with hemorrhagic stroke.

2. Objectives

This research aimed to compare the effectiveness of knee-high and thigh-high graduated compression stockings in the prevention of DVT in patients with hemorrhagic stroke hospitalized at the Askariyeh hospital, Isfahan, Iran.

3. Methods

This randomized clinical trial was conducted from December 2013 to May 2015, on all patients with hemorrhagic stroke hospitalized at the intensive care unit of Askariyeh hospital, Isfahan, Iran. A consecutive sampling method was used to recruit all patients matching the inclusion criteria. Finally, 95 patients were entered in the study. The inclusion criteria included having a medical diagnosis of hemorrhagic stroke, lower limb hemiplegia, absence of DVT in Doppler ultrasound on the first day, and lack of any coagulation disorder in the admission tests. Exclusion criteria included: death of a patient during the study, lack of cooperation in the use of stockings, and failure to perform control Doppler ultrasound for any reason. Using a block randomization method, the patients were randomly assigned to the two groups to use either thigh-high or knee-high compression stockings (Cotton 200, open toe stockings, Sigvaris Co., Switzerland). According to the manufacturer's guideline, these graduated compression stockings apply a pressure of 21 mmHg on the ankle and this pressure decreases in upper areas so that it reaches 18 mmHg in the groin area.

In the study setting, knee-high stockings and physiotherapy are routinely used as prophylaxis procedures for the prevention of DVT in stroke patients. Therefore, the group with thigh-high stockings was considered as the intervention group. Finally, 47 patients were placed in the intervention group and 48 patients in the control group.

3.1. The Procedures

According to the manufacturer's guide, the stockings were covered on the target organ in the morning, after waking the patient (around 7 - 7:30 am) and were removed at night, before sleeping (around 22 - 23 pm). On a daily basis and about 13 - 14 pm, the stockings were removed from the patient's leg by the researcher and the clinical symptoms of DVT (i.e. swelling in the posterior legs, ankle and

thigh; an increase in the leg's circumference, and visibility of the leg's surface vessels) and the possible side effects of stockings (i.e. skin irritation and ulceration) were assessed. Then, the stockings were applied again in the target organ. If a patient was discharged during the study period (before the tenth day), one of the first degree relatives of the patient was selected and trained on how to apply and remove the stockings according to the guidelines provided by the manufacturer. Each patient was visited by the first researcher on a daily basis and for ten consecutive days, for assessment of the clinical symptoms for DVT. In cases of positive clinical symptoms, a Doppler ultrasound was performed immediately and if the results were positive for DVT, they were documented and the concerned neurologist was informed immediately to start specific therapeutic interventions for the treatment of DVT and prevention of secondary complications such as pulmonary embolism. Otherwise, the daily visits were continued till the tenth day and then a Doppler ultrasound was performed. If a patient was discharged before the tenth day, a first degree relative, who was trained, performed the daily assessments and reported the results to the researcher through daily telephone calls that were made by the first researcher.

3.2. Measurements

Data collection tools included two checklists and a Doppler ultrasound machine. The first checklist included questions on patient's demographic characteristics such as age, gender, weight, education level, occupation, and marital status. Also, there were questions on the patient's level of consciousness on arrival to the intensive care unit based on the Glasgow Coma scale (GCS), type of hemiplegia (left or right), the level of mobility before the stroke (i.e. complete immobility, relative mobility (the presence of physical dependence on others to perform daily tasks) and full mobility (lack of physical dependence on others to perform daily tasks)). Moreover, the risk factors of DVT, such as history of DVT and pulmonary embolism, the use of anticoagulant drugs (i.e. heparin, warfarin and aspirin), history of coagulopathies (i.e. impairment of PT, PTT, INR and CBC) and high blood pressure were evaluated. The second checklist included questions on clinical symptoms of DVT (i.e. axillary temperature above 37.8°C, swelling in the posterior leg, ankle and the thigh and outstanding superficial vessels of the legs), symptoms of pulmonary embolism (i.e. respiratory disorders, cough with blood, chest pain at the time of admission and up to ten days after a hemorrhagic stroke, results of Doppler ultrasound on the day of arrival and the tenth day of trial, the onset of clinical symptoms of DVT, the day that the results of Doppler ultrasound for DVT was positive as well as the laboratory results at patient admission (PT, PTT, INR and CBC)). The ap-

plied Doppler ultrasound device in this research was Medison X8 Doppler Ultrasound model that was made in South Korea and all the patients were evaluated by a radiologist through the Doppler ultrasound.

3.3. Ethical Consideration

This study was approved by the ethical committee of Kashan University of Medical Sciences (Registration number T/29/5/1/4076). All patients and one of their first-degree relatives signed a written informed consent form. They were also informed about the study objectives and the process of the study and that they were free to withdraw from the study. This study was registered at the Iranian clinical trial registry and the registry number was IRCT2013120815708N1.

3.4. Data Analysis

Data analysis was performed using the SPSS version 13 software. Due to the lack of normal distribution of data in the Kolmogorov-Smirnov test, Chi-square test was used to compare the qualitative variables of the two groups (i.e. gender, marital status, educational level, job, incidence of DVT). Moreover, Mann Whitney U test was implemented to compare quantitative variables such as age, weight, admission laboratory tests, GCS, and hospitalization duration. The level of significance was set at below 0.05.

4. Results

Of the 95 patients, one from the control group and six from the intervention group were excluded and finally, 41 patients in the intervention group and 47 patients in the control group remained in the study (Figure 1).

The demographic characteristics of patients are shown in Table 1. There was no significant difference between the control and intervention groups in terms of demographic characteristics. Moreover, there were no significant differences between the two groups in the admission laboratory tests (PT, PTT, INR and CBC), mean GCS and hospitalization duration (Table 2). Furthermore, 80.68% of the patients (71 ones) had full mobility before the stroke, and 51.13% and 48.86% had right and left hemiplegia, respectively. However, no significant difference was found between the two groups in the type of hemiplegia (Table 1).

Overall, 29 patients (11 in the intervention group and 18 in the control group) were diagnosed with DVT during the study. Although, the prevalence of DVT was higher in the control group, no statistically significant difference was observed between the two groups (Table 3).

Table 1. The Patients' Demographic Characteristics^a

Variables	Group		P Value
	Intervention	Control	
Gender			0.17 ^b
Male	17 (47.7)	21 (55.3)	
Female	24 (48)	26 (52)	
Marital status			0.56 ^b
Married	36 (45.6)	43 (54.4)	
Single	5 (55.6)	4 (44.4)	
Educational level			0.27 ^b
Illiterate	10 (66.7)	5 (33.3)	
Elementary	21 (41.2)	30 (58.8)	
Secondary or higher	10 (45.4)	12 (54.6)	
Job			0.63 ^b
Housewife	23 (48.9)	24 (51.1)	
Laborer	10 (45.5)	12 (54.5)	
Employee and other businesses	8 (42.1)	11 (57.9)	
Mobility disorders before stroke			0.26 ^b
Dependence on others in motion	10 (24.3)	7 (14.8)	
Lack of dependence	31 (75.6)	40 (85.1)	
Hemiplegia			0.19 ^b
Right	24 (58.5)	21 (44.6)	
Left	17 (41.4)	26 (55.3)	
Age, y	71.92 ± 11.39	68.63 ± 11.25	0.17 ^c
Weight, kg	72.80 ± 9.82	73.70 ± 8.11	0.64 ^c

^aValues are expressed as No. (%) or mean ± SD.

^bChi-Square test was performed.

^cMann-Whitney U test was performed.

5. Discussion

In the present study, 26.8% of the stroke patients in the intervention group (i.e. those who received thigh-high stockings) and 38.3% of the control group (i.e. those who received knee-high stockings) were diagnosed with DVT during the first ten days of hospitalization. Although the prevalence of DVT was considerably higher in the control group, the difference between the two groups was not statistically significant. However, it seems that thigh-high stockings are clinically more effective and the non-significant results of the statistical tests might be attributed to the small sample size of the study groups. A number of previous studies have also compared thigh-high and knee-high stockings. In a study in 2010, thigh-

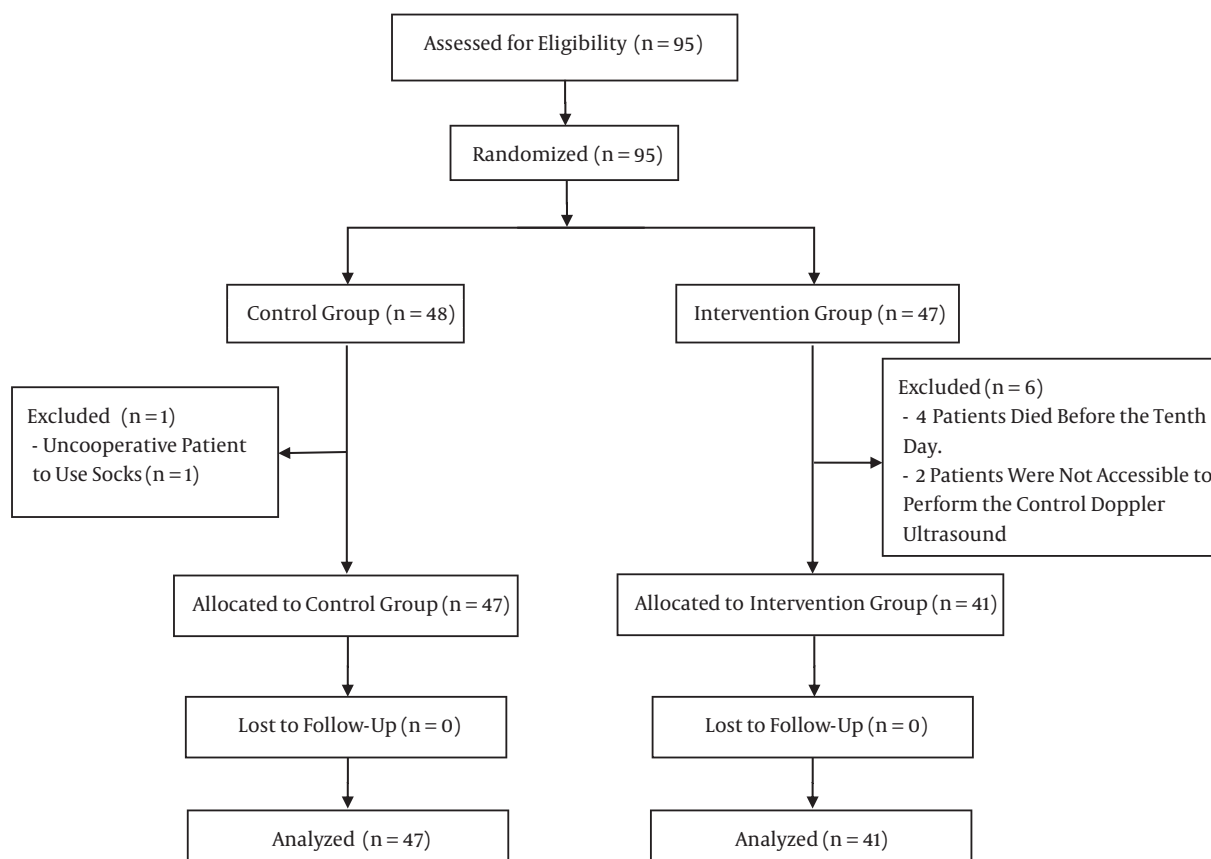


Figure 1. Consort Flow Diagram

Table 2. Mean and Standard Deviation and Inter-Quartile Range of Patients' Characteristics^a

Variable	Group				P Value ^b
	Intervention		Control		
	Mean ± SD	IQR (Q3-Q1)	Mean ± SD	IQR (Q3-Q1)	
Prothrombin time (PT)	12.95 ± 0.77	13 - 13	12.38 ± 0.96	13 - 12	0.31
Partial thromboplastin time (PTT)	29.97 ± 3.25	32.50 - 27.50	29.02 ± 2.93	32 - 26	0.15
International normalized ratio (INR)	0.99 ± 0.13	1.10 - 0.90	0.98 ± 0.13	1.10 - 0.90	0.75
Hemoglobin	14.20 ± 1.34	15.10 - 13	14.10 ± 1.15	15 - 13	0.69
Hematocrit	45.04 ± 4.48	50 - 42	44.44 ± 4.15	49 - 41	0.51
Glasgow Coma Score (GCS)	11.02 ± 1.27	12 - 10	10.91 ± 1.50	12 - 10	0.71
Hospitalization duration, day	11.19 ± 3.85	13 - 8	10.89 ± 3.91	13 - 8	0.71

^aValues are expressed as No., mean ± SD or inter-quartile range.

^bMann-Whitney U test.

high stockings were more effective than knee-high stockings in the prevention of DVT in patients with CVA (17). Amin et al. also reported similar results in a retrospec-

tive study that examined the rate of DVT in patients with acute ischemic stroke (18). However, Dennis et al. reported that thigh-high stockings have no significant effect on re-

Table 3. Distribution of Deep Vein Thrombosis in Patients^a

Deep Vein Thrombosis	Group		P Value (Chi-Square)
	Intervention	Control	
Positive	11 (26.82)	18 (38.29)	0.254
Negative	30 (73.18)	29 (61.71)	

^aValues are expressed as No. (%).

ducing the risk of DVT of the proximal lower limbs in patients with stroke (5). Sajid et al. (19) also conducted a systematic review to compare knee versus thigh-high compression stockings in the prevention of DVT in surgical patients. They reported that the difference was not statistically significant and concluded that knee-high stockings might be better in terms of cost and ease of use. In another review study, Roderick et al. (20) investigated the effects of knee-high versus thigh-high stockings and reported that also both types were effective in the prevention of DVT; it was not possible to conclude which one was more effective.

The sample size and the duration of follow up were limited in this study and both might affect the results. Therefore, it is suggested that similar studies should be conducted with larger sample sizes and longer follow up. Moreover, due to the hemorrhagic nature of the stroke in this study, we had limitations in prescribing anticoagulant medications, while in some of the earlier studies the patients received such medications simultaneous with compression stockings. The results of the present study might not be completely comparable with previous studies.

In conclusion, although the incidence of DVT was somewhat higher in those who used knee-high stockings, however, the difference observed was not statistically significant. Therefore, regarding the ease of use, the cost of stockings and the patient tolerance, one type of stockings can be used.

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Footnotes

Authors' Contribution: Masoumeh Abedzadeh-Kalahroudi was responsible for study concept and design and also supervised the study. Ehsan Azami contributed to searching the literature, data gathering and writing

the first draft. Zohreh Sadat contributed to analyzing the results and their interpretation. Mansour Dianati made critical revision of the paper.

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References

- Bradley WG. Neurology in clinical practice: principles of diagnosis and management. 1. Taylor & Francis; 2004.
- Nishio A, Gotoh TM, Ueki H. [Deep vein thrombosis in the psychiatric patients under physical restraint]. *Seishin Shinkeigaku Zasshi*. 2007;109(11):998-1007. [PubMed: 18203533].
- Kelly J, Rudd A, Lewis RR, Coshall C, Moody A, Hunt BJ. Venous thromboembolism after acute ischemic stroke: a prospective study using magnetic resonance direct thrombus imaging. *Stroke*. 2004;35(10):2320-5. doi: 10.1161/01.STR.0000140741.13279.4f. [PubMed: 15322298].
- Sandercock PAG, Counsell C, Kane EJ. Anticoagulants for acute ischaemic stroke. *Cochrane Library*. 2015.
- Dennis M, Sandercock PA, Reid J, Graham C, Murray G, et al. Effectiveness of thigh-length graduated compression stockings to reduce the risk of deep vein thrombosis after stroke (CLOTS trial 1): a multicentre, randomised controlled trial. *Lancet*. 2009;373(9679):1958-65. doi: 10.1016/S0140-6736(09)60941-7. [PubMed: 19477503].
- Craig LE, Bernhardt J, Langhorne P, Wu O. Early mobilization after stroke: an example of an individual patient data meta-analysis of a complex intervention. *Stroke*. 2010;41(11):2632-6. doi: 10.1161/STROKEAHA.110.588244. [PubMed: 20947855].
- Kelly J, Hunt BJ, Lewis RR, Swaminathan R, Moody A, Seed PT, et al. Dehydration and venous thromboembolism after acute stroke. *QJM*. 2004;97(5):293-6. [PubMed: 15100423].
- Haute Autorite de sante . National Agency for Accreditation and Evaluation in Health Initial management of adult patients with stroke that er'ebreal-me aspects edical 2012. Available from: <http://www.anaes.fr/>.
- Ringleb PA, Boussier MG, Ford G, Bath P, Brainin M, Caso V. Guidelines for management of ischaemic stroke and transient ischaemic attack. *Eur Stroke Organis*. 2008;25(5):457-507.
- Jauch EC, Kissela B, Stettler B, Lutsep H L. Acute Stroke Management. 2016 Available from: <http://emedicine.medscape.com/article/1159752-overview>.
- Baskett J, McNaughton H, Anderson N, Cookson T, Dady K, Fink J. Life after stroke: New Zealand guideline for management of stroke 2012. Available from: <http://www.stroke.org.nz/>.
- Mosti G, Partsch H. Occupational leg oedema is more reduced by antigraduated than by graduated stockings. *Eur J Vasc Endovasc Surg*. 2013;45(5):523-7. doi: 10.1016/j.ejvs.2013.01.032. [PubMed: 23433949].
- Liu R, Lao TT, Kwok YL, Li Y, Ying MT. Effects of graduated compression stockings with different pressure profiles on lower-limb venous structures and haemodynamics. *Adv Ther*. 2008;25(5):465-78. doi: 10.1007/s12325-008-0058-2. [PubMed: 18523736].
- Andreozzi GM, Cordova R, Scomparin MA, Martini R, D'Eri A, Andreozzi F, et al. Effects of elastic stocking on quality of life of patients with chronic venous insufficiency. An Italian pilot study on Triveneto Region. *Int Angiol*. 2005;24(4):325-9. [PubMed: 16355088].
- Clarke M, Hopewell S, Juszcak E, Eisinga A, Kjeldstrom M. Compression stockings for preventing deep vein thrombosis in airline

- passengers. *Cochrane Database Syst Rev.* 2006(2):CD004002. doi: [10.1002/14651858.CD004002.pub2](https://doi.org/10.1002/14651858.CD004002.pub2). [PubMed: [16625594](https://pubmed.ncbi.nlm.nih.gov/16625594/)].
16. Suzanne C, Brenda G, Janice L, Kerry H. Textbook of medical-surgical nursing. Philadelphia: Lippincott Williams & Wilkins; 2008.
 17. Clots Trial Collaboration . Thigh-length versus below-knee stockings for deep venous thrombosis prophylaxis after stroke: a randomized trial. *Ann Intern Med.* 2010;**153**(9):553-62. doi: [10.7326/0003-4819-153-9-201011020-00280](https://doi.org/10.7326/0003-4819-153-9-201011020-00280). [PubMed: [20855784](https://pubmed.ncbi.nlm.nih.gov/20855784/)].
 18. Amin AN, Lin J, Thompson S, Wiederkehr D. Rate of deep-vein thrombosis and pulmonary embolism during the care continuum in patients with acute ischemic stroke in the United States. *BMC Neurol.* 2013;**13**:17. doi: [10.1186/1471-2377-13-17](https://doi.org/10.1186/1471-2377-13-17). [PubMed: [23391151](https://pubmed.ncbi.nlm.nih.gov/23391151/)].
 19. Sajid MS, Tai NR, Goli G, Morris RW, Baker DM, Hamilton G. Knee versus thigh length graduated compression stockings for prevention of deep venous thrombosis: a systematic review. *Eur J Vasc Endovasc Surg.* 2006;**32**(6):730-6. doi: [10.1016/j.ejvs.2006.06.021](https://doi.org/10.1016/j.ejvs.2006.06.021). [PubMed: [16931066](https://pubmed.ncbi.nlm.nih.gov/16931066/)].
 20. Roderick P, Ferris G, Wilson K, Halls H, Jackson D, Collins R, et al. Towards evidence-based guidelines for the prevention of venous thromboembolism: systematic reviews of mechanical methods, oral anticoagulation, dextran and regional anaesthesia as thromboprophylaxis. *Health Technol Assess.* 2005;**9**(49):iii-iv-1-78. [PubMed: [16336844](https://pubmed.ncbi.nlm.nih.gov/16336844/)].