

The effect of knee length and thigh length antiembolism stockings on deep vein thrombosis prophylaxis

Derin ven trombozu profilaksisinde diz altı ve uyluk boyu antiemboli çorapların etkisi

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Background: This study aims to evaluate the effect of the length of anti-embolism stockings on the prevention of postoperative deep vein thrombosis.

Methods: The sample consisted of 44 male patients who underwent radical prostatectomy and urinary diversion. The patients were randomly divided into two groups, including knee length stockings group (n=22; mean age 61.7±9.1 years) and thigh length stockings group (n=22; mean age 62.1±7.0 years). For data collection, the Patient Assessment Form, Deep Vein Thrombosis Symptom Form and Color Doppler Ultrasonography Results of Lower Extremity Deep Venous System were used. Statistical analysis was performed using the chi-square test, Student t-test and Mann-Whitney U analysis.

Results: In the knee length stockings group, the operation time was 174.3±68.6 min and the duration of using antiembolism stockings was 6.1±1.3 days, while the operation time was 177.4±72.9 min in the thigh length stockings group and the duration of using antiembolism stockings was 6.2±1.4 days. According to the results of the lower extremity color Doppler ultrasonography performed before discharge, deep vein thrombosis was not detected in the patients of any group. When the symptoms associated with deep vein thrombosis were evaluated preoperatively and postoperatively, it was observed that a very small number of patients experienced it, however, the diagnosis of deep vein thrombosis was not verified in any of them.

Conclusion: Our study results suggest that there is no difference between knee length and thigh length antiembolism stockings in the prevention of deep vein thrombosis. However, knee length antiembolism stockings are recommended postoperatively to avoid possible complications, due to its ease of use and patient comfort.

Key words: Anti-embolism stockings; deep vein thrombosis; venous thromboembolism.

Amaç: Bu çalışmada antiemboli çorap uzunluğunun ameliyat sonrası derin ven trombozunu önlemeye etkisi değerlendirildi.

Çalışma planı: Radikal prostatektomi ve üriner diversiyon yapılan 44 erkek hasta örnekleme oluşturdu. Randomize edilen hastalar diz altı çorap grubu (n=22; ort. yaş 61.7±9.1), uyluk boyu çorap grubu (n=22; ort. yaş 62.1±7.0 yıl) olmak üzere iki gruba ayrıldı. Verilerin toplanmasında Hasta Tanılama Formu, Derin Ven Trombozu Semptom Formu ve Alt Ekstremitte Derin Venöz Sistemin Renkli Doppler Ultrasonografi Sonuçları kullanıldı. İstatistiksel analizler ki-kare testi, Student t-test ve Mann-Whitney U analizi kullanılarak gerçekleştirildi.

Bulgular: Diz altı çorap grubunda ameliyat süresi 174.3±68.6 dk., antiemboli çorap kullanım süresi 6.1±1.3 gün iken, uyluk boyu çorap grubunda ameliyat süresi 177.4±72.9 dk., antiemboli çorap kullanım süresi 6.2±1.4 gün idi. Taburcu olmadan önce yapılan alt ekstremitte renkli Doppler ultrasonografi sonucunda her iki grupta yer alan hastaların hiçbirinde derin ven trombozu saptanmadı. Derin ven trombozu ile ilişkili olabilen semptomlar ameliyat öncesi ve ameliyat sonrası değerlendirildiğinde, çok az sayıda hastada yaşandığı, ancak hiçbirinde derin ven trombozu tanısının doğrulanmadığı görüldü.

Sonuç: Çalışma bulgularımız ameliyat sonrası derin ven trombozunu önlemede diz altı ve uyluk boyu antiemboli çorapları arasında bir fark olmadığını göstermektedir. Ancak kullanım kolaylığı ve hasta konforu nedeniyle, olası komplikasyonların önüne geçmek için diz altı elastik basınçlı çorabın ameliyat sonrası kullanımı önerilmektedir.

Anahtar sözcükler: Anti-emboli çorabı; derin ven trombozu; venöz tromboemboli.



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Deep vein thrombosis (DVT) and pulmonary embolism (PE) are common complications of open urological surgical intervention in which the thrombi and emboli are clinically silent, leading to sudden death as well as a substantial rise in health care expenditures.^[1,2] This condition is related to patient risk factors, surgery type and time, degree and duration of postoperative inactivity, and the use of prophylactic methods. The risk of DVT is estimated to be 32% for patients undergoing an open prostatectomy,^[3] but the rate of DVT after an open prostatectomy with the use of prophylaxis ranges from only 0.8% to 6.2%.^[3]

Although there are prophylactic methods that are proven and routinely performed to prevent DVT and PE throughout the whole world, they may be neglected in clinical practices.^[4-6] Considering the risk/benefit ratio of the use of prophylactic methods, previous studies demonstrated that the benefits were higher and that they were cost-effective.^[7-8] The American College of Chest Physicians (ACCP) has recommended antithrombotic and thrombolytic therapy for surgical patients. Accordingly, despite the strong evidence supporting these types of therapy which avoid the formation of thrombus, patient safety is neglected due to inadequate doses and treatment duration.^[9]

As a mechanical method in the prevention of DVT, anti-embolism stockings increase the venous blood flow velocity, prevent venous stasis, and improve valvular function.^[10,11] Their profile is equal to the Sigel profile (18 mmHg at the ankle, 14 mmHg at the mid-calf, 8 mmHg at the popliteal, 10 mmHg at the mid-thigh and 8 mmHg at the upper thigh) and they achieve level 1 in best clinical evidence.^[12] According to a report by the Cochrane Library, the incidence of DVT was 13% in patients who wore anti-embolism stockings and 26% in those who were not treated with any prophylactic method.^[13] When anti-embolism stockings are used alone, they reduce the incidence of DVT by over 60% and when they are, used as an adjuvant to mechanical or pharmacological methods of prophylaxis, they further reduce the incidence by up to 85%.^[11] Clinical guides recommend the use of anti-embolism stockings for both low-risk and high-risk patients.^[11]

The effect of the length of anti-embolism stockings on the prevention of DVT is unclear. As a result of a meta-analysis conducted by Sajid et al.,^[14] best clinical evidence (level 1) is required to prove that knee length stockings can be as effective as thigh length stockings for the prevention of DVT. In the 2007 report of the National Institute for Health and Clinical Excellence (NICE),^[15] knee length anti-embolism stockings were

recommended if thigh length ones were not suitable, whereas the 2010^[16] report states that either knee length or thigh length anti-embolism stockings can be used. It is known that the thigh length stockings reduce the risk of DVT by 63% when compared with those that are below the knee.^[10] In the best practices, which were published later, it is stated with level 1 evidence that thigh length stockings should be used unless postoperatively contraindicated; however, if there is a failure of compliance, knee length anti-embolism stockings can be used as an alternative.^[12]

A review of the literature showed that anti-embolism stockings are recommended for the prevention of DVT, but as of yet, no consensus has not been reached regarding which length of stocking is the best.

Therefore, we conducted a prospective randomized study to evaluate the effects of knee length and thigh length anti-embolism stockings on the prevention of postoperative DVT.

PATIENTS AND METHODS

Settings and samples

Our study population began with 75 male patients who had undergone elective major pelvic surgery or had open prostatectomies, radical prostatectomies, radical cystectomies, or urinary diversion between September 2010 and June 2011.

However, only 44 of the original 75 patients were included in the study, as 31 (58.7%) were excluded due to the presence of DVT (n=2), massive leg edema (n=1) venous insufficiency (n=1), refused to participate (n=7) and technical reasons (n=18). Knee length anti-embolism stockings were used by 22 of the study participants (mean age 61.7±9 years, and 22 others (mean age 62.1±7.0 years) used thigh length ones.

All patients gave both their verbal and written consent to be included in the research, and written approval for the study was obtained from the Faculty of Medicine Research Ethics Board, School of Nursing Scientific Ethics Committee, and Faculty of Medicine, Hospital Management.

Once the study population was confirmed, the 44 patients were then randomized using the block randomization method (Figure 1).

Data collection and procedure

The patients' predisposing and exposing factors related to DVT were analyzed using the "Patient Identification Form", which had been prepared by the researchers.

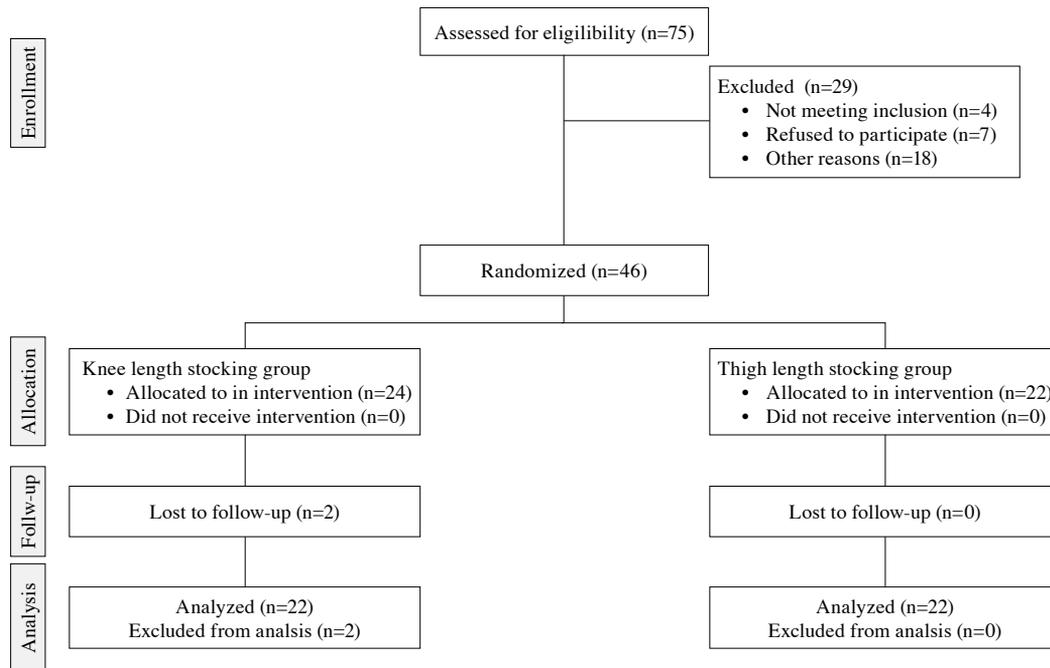


Figure 1. Consort.

Mediven® Thrombexin® 18 mmHg knee length and thigh length anti-embolism stockings, which comply with the Sigel profile, were given to the patients, and they used them throughout the preoperative, intraoperative, and postoperative period until they were discharged.

All of the patients had practical training regarding DVT, the use of the stockings, and foot-leg exercises and were also supplied with educational booklets on these subjects to help them better understand their situation.

Patients underwent color Doppler ultrasonography (USG) of the lower extremity deep venous system by a specialist both preoperatively and postoperatively before discharge. In large-scale studies of DVT, the sensitivity of color Doppler USG for the lower extremity deep venous system is normally at 95% while its specificity is at 99%.^[8] Through the use of this type of imaging, the main and external iliac, main, deep femoral, and superficial femoral veins, popliteal veins, and deep crural segments on both sides can be structurally and hemodynamically analyzed.

Various symptoms that have a possible connection with DVT were evaluated, including leg pain, night cramps, heat or a burning sensation, activity limitations, dilated superficial veins, and edema. In addition, all patients were measured for ankle circumference, calf circumference, and thigh circumference.

From the first day of the postoperative period, the patients were injected daily with standard low molecular weight heparin (LMWH) (40 mg enoxoparin 1x1) until discharge.

The research data was collected preoperatively and before discharge (6 days ± 1 day on average).

Statistical analysis

The data was analyzed by a specialist from the Department of Biostatistics and Medical Informatics using the SPSS (SPSS Inc., Chicago, Illinois, USA) version 18.0 for Windows software program.

A chi-square, Fisher’s exact analysis was performed for group comparison of nominal values. Among the numerical variables, those which demonstrated a normal distribution were analyzed using Student’s t-test while the others were analyzed with the Mann-Whitney U test. The threshold level of statistical significance was established at $p < 0.05$.

RESULTS

None of the patients had hereditary or acquired thrombophilia. We determined that 31.8% of the patients (n=14) smoked, 52.3% (n=23) had a history of surgery, 2.3% (n=1) had a history of DVT, 9.1% (n=4) had a family history of DVT, 11.4% (n=5) had myocardial infarction (MI), 27.2% (n=12) had cardiac insufficiency, and 13.6% (n=6) had varicose veins (Table 1).

Table 1. Patient characteristics (Predisposing Factors)

Characteristics	Knee length stocking group (n=22)	Thigh length stocking group (n=22)	Total (n=44)	Fisher's exact test
	%	%	%	p
Smoking	31.8	31.8	31.81	1.00
Surgery history	59.1	45.5	52.27	0.547
Deep vein thrombosis history	–	4.5	2.27	1.00
Family history deep vein thrombosis	9.1	9.1	9.09	1.00
Myocardial infarction history	13.6	9.1	11.36	1.00
Cardiac insufficiency	31.8	22.7	27.22	0.736
Varicose veins	9.1	18.2	13.63	0.664

The mean BMI of the patients in the knee length stocking group was 26.9 ± 4.6 while it was 28.5 ± 3.4 ($p=0.073$) in the thigh length stocking group. The median platelet count was $251,000\pm 107,750$ mm³ in the knee length stocking group and $199,500\pm 93,000$ mm³ in the thigh length stocking group, ($p=0.057$), and the average prothrombin (PT) time was 12.1 ± 2.0 seconds in the knee length stocking group and 11.7 ± 0.6 seconds in the thigh length stocking group ($p=0.816$) (Table 2).

Prostate cancer was diagnosed in 81.8% of the patients in the knee length stocking group and 77.3% of the thigh length stocking group, and these patients underwent radical prostatectomies. In addition, 18.2% of the patients in the knee length stocking group and 22.7% of those in the thigh length stocking group were diagnosed with bladder tumors and underwent total cystectomies and urinary diversion surgery ($p=1.00$) (Table 3).

General anesthesia was given to 86.4% of the patients in the knee length stocking group and 95.5% of those in the thigh length stocking group ($p=0.607$). Furthermore, 100% of the knee length group and 95.5% of the thigh length stocking group were kept in the supine position ($p=1.00$). The average operation time was 174.3 ± 68.6 minutes for patients who wore knee length stockings and 177.4 ± 72.9 minutes for those who wore thigh length ones ($p=0.882$) (Table 3).

Enoxaparine sodium (40 mg) was given to 77.3% of the patients in the knee length group and 81.8% of thigh length stocking group ($p=1$). The median

mobilization time was 20.0 ± 2.3 hours and 21.0 ± 2 hours in the knee length and thigh length stocking groups, respectively ($p=0.700$). In addition, the average duration of anticoagulant therapy was 5.3 ± 1.1 days for the knee length stocking group and 5.4 ± 1.6 days for the thigh length ($p=0.828$). We also discovered that the average duration of anti-embolism stocking use was 6.1 ± 1.3 days and 6.2 ± 1.4 days for the knee length and thigh length stocking groups, respectively ($p=0.825$) (Table 4).

According to the results of the color Doppler USG performed postoperatively, DVT was not diagnosed in any of the 44 patients in our study, and only two patients in the knee length stocking group and one in the thigh length stocking group experienced symptoms associated with DVT such as pain, night cramps, heat or a burning sensation, activity limitations, dilated superficial veins, edema, or an increase in foot, leg and calf circumference when examined postoperatively before discharge.

DISCUSSION

In this study, the effects of knee length and thigh length anti-embolism stockings related to the prevention of DVT in patients who underwent radical prostatectomies or radical cystectomies and urinary diversion were evaluated.

Previous literature revealed that the risk of DVT formation increases beginning at the age of

Table 2. Preoperative patient characteristics (predisposing factors)

Characteristics	Knee length stocking group		Thigh length stocking group		Z	t	p
	Mean±SD	Min.-max.	Mean±SD	Min.-max.			
Body mass index (kg/m ²)	26.8±4.5	20.9-37.3	28.4±3.4	22.9-37.8			3.383*
Platelet count (mm ³)	251,000±107,750	148,000-357,000	199,500±93,000	129,000-650,000	-1.902‡		0.057
Prothrombin time (seconds)	12.0±1.9	11.0-20.6	11.7±0.6	10.6-12.8			-0.234*

SD: Standard deviation; Min.: Minimum; Max.: Maximum; ‡ Mann-Whitney U test; * t-test.

Table 3. Intraoperative patient characteristics (exposing factors)

Characteristics	Knee length stocking group (n=22)			Thigh length stocking group (n=22)			t	p
	%	Mean±SD	Min.-max.	%	Mean±SD	Min.-max.		
Diagnosis and operation								
Prostate carcinoma + Radical prostatectomy	81.8			77.3				
Bladder tumor + radical cystectomy and diversion	18.2			22.7				1.00*
Anesthesia								
General	86.4			95.5				0.607*
Spinal	13.6			4.5				
Operation position								
Supine	100.0			95.5				1.00*
Lithotomy	–			4.5				
Operation time (minutes)		174.3±68.6	90-360		177.5±72.8	105-315	-0.149‡	0.882

SD: Standard deviation; Min.: Minimum; Max.: Maximum; * Fisher's exact test; ‡ t-test.

40 and 1/2 is women and man risk ratio.^[4,17-19] It is estimated that predisposition to thrombosis is associated with genetic factors at a rate of higher than 60%. Thrombophilia is also a risk factor,^[19] but none of the older men in our study had this disorder.

People who smoke and those who have undergone surgery in the past three months, especially if it was orthopedic, abdominal or thoracic in nature, also have an increased risk of DVT.^[17-19] In our study, the majority of the patients did not smoke and no significant differences were seen in either group regarding the risk of DVT between those who had undergone a recent operation and those who had not.

Previously published clinical guides showed that having a personal or family history of DVT creates the risk of a new thrombus formation.^[17-19] Additionally, these showed that patients with a history of an MI within the past month had a much higher risk of DVT.^[17-19] In this study, the vast majority of the patients did not have a personal or family history of DVT or a history of an MI.

For patients with cardiac insufficiency, varicose veins, and a BMI ≥ 25 kg/m² the risk of DVT also increases.^[12,15-20] The patients in both of our groups experienced cardiac insufficiency and varicose veins at low rates, but the mean BMI was above 25 kg/m². However, none were diagnosed with DVT.

According to Virchow's cell theory, changes in coagulation have a significant effect on the formation of venous thrombosis^[21,22] and that these changes can be identified via abnormalities in platelets and PT.

However, the average platelet and PT values of the patients in our study were within normal ranges.

The NICE report stated that in cases of surgical interventions that last for more than 90 minutes and pelvic and lower extremity operations that last longer than 60 minutes, the risk of DVT increases.^[15] Furthermore, the risk also is higher in cases in which general anesthesia was used rather than local anesthesia and in patients placed in the lithotomy position after urological surgery.^[10-16] In our study, almost all of the patients who underwent radical prostatectomies and urinary diversion were given general anesthesia and kept in the supine position. Although the average operation time was above 90 minutes, none of the study participants developed DVT.

A guide published by the Agency for Healthcare Research and Quality (AHRQ) recommended standard and LMWH for patients who are postoperatively under a medium or high risk of DVT. In spite of this, the preventive dose and duration of these methods are underutilized since these drugs present bleeding complications in clinical practices.^[23] In our study, LMWH was given in the first postoperative 24 hours in the manner recommended by clinical guides. The drug dose was increased for obese patients.

Immobility is a major risk factor for DVT.^[19] When mobility is reduced for three days or more^[16] or when one is sitting in a confined space for more than eight hours,^[14] a significant development of DVT is expected. We found that the average postoperative mobilization

Table 4. Postoperative patient characteristics (exposing factors)

Characteristics	Knee length stocking group (n=22)			Thigh length stocking group (n=22)			Z	t	p
	%	Mean±SD	Min.-max.	%	Mean±SD	Min.-max.			
LMWH dosage (daily)									
40 mg/day	77.3			81.8					1.00*
60 mg/day	22.7			18.2					
Mobilization time (hours)		20.0±2.2	17-23		21.0±2	17-41	-0.385¶		0.70
Duration of LMWH therapy (days)		5.2±1.0	3-7		5.3±1.6	3-10		-0.219‡	0.828
Duration of stocking use (days)		6.0±1.3	4-8		6.1±1.4	3-8		-0.223‡	0.825

SD: Standard deviation; Min.: Minimum; Max.: Maximum; LMWH: Low molecular weight heparin; * Fisher's exact test; ¶ Mann-Whitney U-test; ‡ t-test.

time of the patients in both of our study groups was within the first 24 hours. This leads to the hypothesis that early postoperative mobilization could be a major factor for the prevention of DVT.

With surgical advances, the duration of hospital stay has generally dropped below five days. However, for preventive treatment of DVT, a minimum of seven to 10 days is recommended. When patients are discharged, they are subjected to the risk of DVT due to inadequate preventive treatment. The concomitant use of LMWH and anti-embolism stockings is the most practical application in surgery and provides effective protection.^[14] On the other hand, there is no standardized recommendation regarding how long to use anti-embolism stockings after surgery. The patients in our study used them for nearly a week.

According to our results, the benefits obtained from the use color Doppler USG do not merit the high cost, and we cannot recommend it except in cases where the risk of DVT is high.

Multiple studies have revealed that symptoms such as calf pain, heat or a burning sensation, limitation of movement in the affected leg, dilated superficial veins, edema, and increase in the measurement of the leg could indicate DVT.^[12-19] Only three of our patients experienced these symptoms and no diagnosis of DVT was verified by the color Doppler USG. However, two patients who were not included in the sampling demonstrated symptoms of DVT, and the color Doppler USG did verify the DVT diagnosis in these cases.

Although to our knowledge, no study has not been conducted concerning the length of anti-embolism stockings in a urological patient group, Hui et al.^[24] stated that knee length stockings significantly reduced the rate of proximal and major calf thromboses in patients who had knee replacement, but no significant differences were noted in the overall thrombosis rates

in the hip replacement or knee replacement patients in their study, which suggests that the length of the stockings may not be important. A systematic review of the literature published between 1993 and 1999 revealed that nine of the 10 articles on the topic concluded that knee length anti-embolism stockings were as effective as thigh length ones, and none of the four randomized controlled trials that were examined showed a significant difference between the two types of stockings.^[25]

In the study by Howard et al.^[26] there was no significant difference between the Kendall T.E.D brand of thigh length anti-embolism stockings and the Mediven® Thrombexin® knee length anti-embolism stockings. However, the Mediven® Thrombexin® Climax thigh length anti-embolism stockings significantly decreased the incidence of DVT when compared with calf-high anti-embolism stockings. According to a meta-analysis of 14 studies that demonstrated the incidence of DVT between 1976 and 2005, there was very little evidence to support a significant difference in the efficacy between knee length and thigh length anti-embolism stockings. This was especially true in the five studies conducted with surgical patients in which knee length anti-embolism stockings reduced the risk of DVT by 6% while thigh length stockings reduced it by 4%.

Our study had the limitation of including only male patients who underwent open radical prostatectomies or radical cystectomies and urinary diversion. In addition, our results were not supported by a power analysis, and the sample size of our study was small. Therefore, our results cannot be generalized to include the population as a whole.

In conclusion, our study show that knee length and thigh length anti-embolism stockings had an equal effect on the prevention of postoperative DVT. Accordingly, knee length stockings are recommended

for the postoperative period in terms of patient safety, comfort, ease of use, prevention of labor loss, and cost-effectiveness. Because of the high cost, we also cannot recommend that surgical patients undergo routine color Doppler USG of the low extremity deep vein system; however, it is recommended for patients at high-risk of DVT.

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