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Prevalence and Countermeasures for Venous Thromboembolic Diseases Associated With Spinal Surgery

A Follow-up Study of an Institutional Protocol in 209 Patients

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Study Design. A prospective study of 209 patients undergoing spinal surgery.

Objective. To determine the incidence of venous thromboembolic diseases, including deep venous thrombosis (DVT) and pulmonary embolism (PE), and to evaluate the effectiveness of an institutional protocol for venous thromboembolic diseases during the spinal surgery perioperative period.

Summary of Background Data. Although patients undergoing spinal surgery are at risk of venous thromboembolism (VTE), there are no universally accepted guidelines for VTE prophylaxis.

Methods. Between December 2006 and January 2011, 209 patients undergoing spinal surgery (121 males, 88 females; average age: 64 yr), who also had ultrasonographic assessments of both legs before and after surgery, were prospectively assessed. A pneumatic sequential compression device and standard compression stockings were used for primary VTE prophylaxis. In Mie University Hospital protocol, pharmacological agents were not used for VTE prophylaxis after surgery. However, when a distal type DVT was found preoperatively, an anticoagulant medication was administered until 6 hours prior to surgery. After detection of DVTs, weekly ultrasonography assessed the DVT.

Results. Twenty-three patients (11.0%) showed VTE in the spinal surgery perioperative period. Nine patients (4.3%) had VTE (PE with proximal DVT, 1 [0.5%]; distal DVT, 8 [3.8%]) before surgery. In the one case of asymptomatic PE with proximal DVT, an inferior vena cava filter was placed before surgery. Fourteen patients (6.7%) developed new-onset VTE (PE with proximal DVT, 2 [1.0%]; distal DVT, 12 [5.9%]) after spinal surgery. New-onset PE with proximal DVT occurred in 2 patients after surgery. Follow-up ultrasonographic assessment showed that the DVT disappeared completely in 85% (17/20) of patients with a distal type DVT during the perioperative period.

Conclusion. DVT assessment using ultrasonography is important for proper management of VTE during the perioperative period of spinal surgery, especially for high-risk patients, such as those with advanced age or neurological deficit. The institutional protocol for VTE using pneumatic sequential compression device and compression stockings is effective, although the administration of chemoprophylaxis should be considered for high-risk patients, such as those with spinal tumors and spinal trauma.

Key words: venous thromboembolism, deep venous thrombosis, pulmonary embolism, spinal surgery.

Level of Evidence: 3

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Patients undergoing major orthopedic surgery have a potential risk of venous thromboembolism (VTE) including deep venous thrombosis (DVT) and pulmonary embolism (PE).[1] Therefore, it is important to take measures effective for preventing and countering VTE during the perioperative period of major orthopedic surgery.

There have recently been a number of published reports on the incidence of and countermeasures used for VTE after spinal surgery; however, it is difficult to interpret the data. The incidence of DVT in spinal surgery, ranging from 0.3% to 31% depending on the patient population, and the method of surveillance (see review in Glotzbecker *et al*[2]), have been reported to be considerably lower than that for major lower-extremity surgery.[3]

Patients undergoing spinal surgery may have increased possibility for DVT/VTE because they often present with a neurological deficit. To our knowledge, reports of preoperative DVT in patients undergoing spinal surgery are few.[4–6]

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Various prophylactic measures, including mechanical prophylaxis,[4–9] chemical prophylaxis[10–12] and the placement of inferior vena cava filters[13,14] have been reported for prevention of DVT and/or PE after spinal surgery. However, the administration of chemoprophylaxis associated with spinal surgery remains controversial because of the risk of symptomatic postoperative epidural hematoma.[2,7,10–12,15,16] The eighth American College of Chest Physicians guidelines do not recommend thromboprophylaxis for all patients undergoing spinal surgery.[1] Under present circumstances, the prophylactic use of anticoagulant agents, including low-molecular-weight heparin (LMWH) and/or Factor Xa inhibitors, before and/or after spine surgery has not been approved globally.

There are no universally accepted guidelines that recommend a specific protocol for DVT prophylaxis in patients undergoing spinal surgery. Therefore, on the basis of perioperative VTE prophylaxis during major joint surgery at Mie University Hospital,[3,17–19] we have established an institutional protocol for VTE in the spinal surgery perioperative period without the use of antithrombotic agents after spinal surgery.

The purposes of this study were (1) to determine the pre- and postoperative incidence of DVT/PE, and (2) to evaluate the effectiveness of Mie University Hospital preventive protocol without the use of antithrombotic agents after spinal surgery.

MATERIALS AND METHODS

Study Design

This study was a prospective clinical trial performed at Mie University Hospital, Mie, Japan. The study was performed on the basis of the Declaration of Helsinki and the protocol was approved by the Ethics Committee of the University of Mie. All participants provided informed consent to participate in this study.

Patients

Between December 2006 and January 2011, there were 256 patients who underwent spinal surgery in Mie University Hospital. We prospectively assessed the 209 patients undergoing spinal surgery (121 males, 88 females; average age: 64 yr) who had also undergone ultrasonographic assessment of both legs before and after spinal surgery (Table 1). The patients had spinal surgery for degenerative spinal diseases (n = 147), metastatic spinal tumor (n = 21), primary spinal tumor and spinal cord tumor (n = 7), spinal trauma (n = 10) and other (n = 24). For each patient, age (at the time of surgery), body mass index (BMI), operation time, intraoperative blood loss, and the existence of comorbidity (*e.g.*, diabetes mellitus, ischemic cardiac disease, and hypertension) were recorded (Table 1).

Ultrasonographic Assessment

Ultrasonographic scans were performed as previously reported.[3] Briefly, bilateral ultrasonography of both legs (97.5- or 10-MHz liner probe with pulse and color Doppler, ProSound α5SV; Aloka Company, Tokyo, Japan) was performed by physicians with experience in this procedure. Veins were compressed every 1 to 2 cm, moving from the proximal to the distal end of the venous segment. The venous segments scanned were calf muscle veins, anterior and

TABLE 1. Patient Demographics and Clinical Data

	Overall	Preoperative DVT Negative	Preoperative DVT Positive	Postoperative DVT Negative	Postoperative DVT Positive
Number of cases	209	200	9	195	14
Sex					
Male	121	117	4	111	10
Female	88	83	5	84	4
Average age (yr)	64.0 ± 17.1	63.4 ± 17.2	76.0 ± 7.2†	63.9 ± 17.5	65.7 ± 9.8
BMI (kg/m^2)	23.2 ± 4.2	23.2 ± 4.3	23.1 ± 3.6	23.2 ± 18.3	23.4 ± 3.8
Comorbidities					
DM	42/209 (20.1%)	40/200 (20%)	2/9 (22.2%)	40/195 (20.5%)	2/14 (14.3%)
Cardiocirculatory diseases	31/209 (14.8%)	28/200 (14%)	3/9 (33.3%)	30/195 (15.4%)	1/14 (7.1%)
Hypertension	80/209 (38.3%)	72/200 (36%)	8/9 (88.9%)*	74/195 (37.9%)	6/14 (42.9%)
Operation time (min)	168.0 ± 82.1	167.7 ± 82.4	173.8 ± 79.2	165.9 ± 82.1	196.7 ± 79.0
Intraoperative bleeding (mL)	640.6 ± 1123.0	637.8 ± 1139.1	702 ± 714.2	608.5 ± 1080.5	1087.0 ± 1589.0

Overall patient data are classified with/without preoperative and postoperative DVT.

DVT indicates deep venous thrombosis; BMI, body mass index.

**P ≤ 0.01.*

†P ≤ 0.05 vs. patients with negative DVT preoperatively.

posterior tibial veins, and the popliteal vein, femoral vein, and common femoral vein. The results of ultrasonography were considered positive if a vein or venous segment was not fully compressible. Patients with thrombi were classified by thrombus location as below the popliteal level within the calf muscle veins (distal type thrombi: distal DVT) or at the popliteal and femoral veins (proximal type thrombi: proximal DVT). Ultrasonographic scans were performed preoperatively and repeated within 4 days after surgery.

Institutional Protocol for Venous Thromboembolic Diseases During the Spinal Surgery Perioperative Period

Our perioperative protocol for VTE before and after spine surgery is based on the VTE protocol for total-knee arthroplasty and/or total-hip arthroplasty of Mie University Hospital.[3,17–19] That protocol used pneumatic sequential compression devices (PSCDs) and standard compression stockings as primary prophylaxis. Pharmacological agents were not used after surgery in this protocol with the following exceptions: (1) When a proximal DVT was found before and/or after spinal surgery, cardiovascular internal medicine was consulted and anticoagulant medication was started. An inferior vena cava filter was installed when required. (2) If a distal DVT was found preoperatively, an anticoagulant (heparin 500 U/hr) was administered to the patient to adjust the activated partial thromboplastin time to 40 to 50 seconds until 6 hours prior to surgery. Early postoperative ambulation was also prescribed and weekly ultrasonographic assessments were performed. (3) When a new distal DVT was found postoperatively, early postoperative ambulation was prescribed and weekly ultrasonographic assessments were performed.

Statistical Analysis

The incidence of DVT was evaluated in relation to classification of spinal disorders, sex, age, BMI, operation time, intraoperative blood loss, and the existence of comorbidity (diabetes mellitus, ischemic cardiac disease and hypertension). All data are expressed as the mean ± standard deviation. Statistical analysis was performed using the StatView program (version 5.0; SPSS, Chicago, IL) using the χ^2 test, Fisher exact probability test, and Student *t* test as appropriate. Statistical significance was accepted at $P < 0.05$.

RESULTS

Preoperative VTE

Preoperative VTE was found in 9 patients (4.3%); asymptomatic PE with proximal DVT in 1 patient (0.5%), and distal DVT in 8 patients (3.8%) (Tables 1, 2). These 9 patients underwent spinal surgery due to degenerative spinal diseases (n = 5), metastatic spinal tumor (n = 1), spinal trauma (n = 2), and other (cervical and thoracic ossification of posterior longitudinal ligament, n = 1).

Proximal DVT before surgery was found in one 80-year-old patient with lumbar canal stenosis and a history of L3 and L4 vertebral fracture. Preoperative ultrasonography-detected venous thrombosis of the left common femoral vein, left superficial femoral vein, and left soleus vein. On computed tomographic contrast angiography, thrombi in the right pulmonary artery were found. Anticoagulant therapy (heparin IV 800 U/hr) was administered and an inferior vena cava filter was placed. Five weeks after administration of anticoagulant therapy, posterior decompression, and posterolateral fusion were performed. Three weeks after surgery the disappearance

TABLE 2. Preoperative DVT and PE in Patients Undergoing Spinal Surgery

Case	Age/Sex	Diagnosis	Procedure	DVT Type	Location	Negative DVT
1	80/F	Lumbar spinal canal stenosis	PLF	Proximal (PE)	Lt. CFV, SFV, soleus	POD 14
2	63/M	Lumbar spinal canal stenosis	Laminotomy	Distal	Lt. soleus v.	POD 1
3	73/F	Lumbar spinal canal stenosis	Laminotomy	Distal	Lt. soleus v.	Chronic DVT+
4	84/F	OPLL (cervical and thoracic spine)	Laminoplasty	Distal	Lt. peroneal v., soleus v.	Lost to follow-up
5	77/F	Lumbar vertebral fracture	Spinal fusion with instrumentation	Distal	Lt. peroneal v.	POD 14
6	74/M	Thoracic disc herniation	Laminoplasty	Distal	Lt. soleus v.	After discharge
7	87/M	Spinal metastasis (renal carcinoma)	Spinal fusion with instrumentation	Distal	Rt. soleus v.	POD 22
8	76/M	Cervical myelopathy	Anterior decompression and fusion	Distal	Rt. soleus v.	POD 17
9	70/F	Vertebral fracture (T12)	Spinal fusion with instrumentation	Distal	Rt. soleus v.	Lost to follow-up

PLF indicates posterolateral fusion; OPLL, ossification of posterior longitudinal ligament; CFV, common femoral vein; SFV, superficial femoral vein; POD, postoperative day; DVT, deep venous thrombosis; PE, pulmonary embolism; Rt., right; Lt, left; Bil., bilateral; soleus v., soleus vein; peroneal v., peroneal vein.

of both DVT and PE was confirmed. On preoperative ultrasonography, distal DVT was found in 8 other patients. In all 8, distal DVT was found in a unilateral soleus vein; one patient (case 4) had left peroneal and soleus veins involved (Table 2). These patients underwent preoperative anticoagulant therapy as prescribed by the institutional protocol. There were no significant differences in operation time and intraoperative bleeding between patients who were DVT positive and those who were DVT negative preoperatively (Table 1).

After surgery none of the 8 patients developed proximal DVT and/or symptomatic PE. The results of the follow-up DVT survey confirmed disappearance of DVT in 5 patients. Among these, the disappearance of DVT during the hospitalization period was confirmed in 4 patients. The average time to confirmed disappearance of DVT during the hospitalization period was 13.6 days. In one patient, the negative DVT was confirmed after discharge. One persisting obsolete thrombotic organization was found in the left soleus vein of one patient. Two patients were lost to follow-up (Table 2).

Postoperative VTE

Fourteen patients (6.7% of total) developed new-onset VTE (DVT and PE) after spinal surgery. The average age (65.7 ± 9.8 yr) was similar to that of patients with negative DVT postoperatively (63.9 ± 17.5 yr). The average operation time was somewhat longer, and the average amount of intraoperative bleeding was somewhat larger than that for patients with negative DVT postoperatively, although no differences were significant (Table 1).

Among the 14 patients, postsurgical PE with proximal DVT developed in 2 (1.0% of total) (Table 3). The first patient, a 54-year-old male, had surgical removal of an intramedullary tumor (astrocytoma) in the thoracic spine that had produced motor paresis in a leg. Twenty-three days after surgery, the patient developed proximal DVT and asymptomatic PE. Anticoagulant therapy was administered. The second patient, a 68-year-old male, underwent laminoplasty for a spinal cord injury with pre-existing cervical spondylosis with motor paresis in upper and lower extremities. Nineteen

TABLE 3. DVT and PE in Patients Undergoing Spinal Surgery

Case	Age/Sex	Diagnosis	Procedure	DVT Type	Location	Positive DVT	Negative DVT
1	54/M	Thoracic spinal tumor	Spinal tumor resection	Proximal	Day 14: rt. soleus v. / day 23: lt. CFV.	Day 14/23	Day 49
2	68/M	Spinal cord injury	Laminoplasty	Proximal	Lt. CFV.	Day 19	Day 45
3	77/M	Pyogenic spondylitis	Laminectomy	Distal	Bil. soleus v.	Day 20	Day 42
4	62/M	Atlantoaxial dislocation	Spinal fusion (O–C4)	Distal	Bil. soleus v.	Day 1	Day 14
5	80/M	Lumbar spinal canal stenosis	Spinal fusion (PLF w/o instrumentation)	Distal	Rt. soleus v.	Day 2	After discharge
6	59/M	Spinal metastasis	Laminectomy	Distal	Rt. soleus v.	Day 7	After discharge
7	61/M	Spinal metastasis	Spinal fusion with instrumentation	Distal	Rt. soleus v.	Day 1	Day 20
8	55/M	Lumbar spinal canal stenosis	Laminotomy	Distal	Rt. soleus v.	Day 1	Day 14
9	61/F	Atlantoaxial dislocation	Spinal fusion (O–C4)	Distal	Rt. soleus v.	Day 2	After discharge
10	81/F	Spinal metastasis	Spinal fusion with instrumentation	Distal	Lt. soleus v.	Day 6	After discharge
11	61/F	Lumbar spinal canal stenosis	Spinal fusion (PLF w/o instrumentation)	Distal	Lt. soleus v.	Day 6	Day 48
12	80/M	Lumbar spinal canal stenosis	Spinal fusion (PLF with instrumentation)	Distal	Lt. soleus v.	Day 9	Day 18
13	65/M	Lumbar spinal canal stenosis	Laminotomy	Distal	Rt. soleus v.	Day 1	Day 12
14	56/F	Lumbar vertebral fracture	Vertebroplasty with instrumentation	Distal	Bil. soleus v.	Day 1	After discharge

PLF indicates posterolateral fusion; CFV, common femoral vein; DVT, deep venous thrombosis; PE, pulmonary embolism; Rt., right; Lt, left; Bil., bilateral; soleus v., soleus vein.

days after surgery, this patient developed symptoms of PE. Upon diagnosis of proximal DVT (thrombi of the left common femoral vein) and PE (thrombi of left pulmonary artery), anticoagulant therapy was initiated and an inferior vena cava filter placed.

Distal DVT developed in 12 patients (5.9%) after surgery. The average date of first detection of distal DVT after spinal surgery was 4.75 ± 5.6 days. These patients were followed by weekly ultrasonographic scans. None of these patients developed proximal DVT and/or symptomatic PE. The disappearance of DVT was confirmed in all 12 patients with negative DVT being confirmed during the hospitalization period in 9. The average time to confirmation of negative DVT during hospitalization was 24.0 days. In the remaining 5 patients, negative DVT was confirmed after discharge (Table 2).

Risk Factors for Developing Pre- and Postoperative DVT

The average age (76.0 ± 7.2 yr) of preoperative DVT-positive cases was significantly older than that of preoperative DVT-negative cases (63.4 ± 17.2 yr, $P \leq 0.05$, Student *t* test) (Table 1). There was no significant association between preoperative DVT and sex, BMI, operation time, intraoperative blood loss, and the existence of comorbidity (diabetes mellitus, ischemic cardiac disease, and hypertension). However, there was a significant ($P \leq 0.01$; Fisher exact probability test) association between preoperative DVT and the comorbidity of hypertension (Table 1). The risk factors, including age, sex, BMI, operation time, intraoperative blood loss, and the existence of a comorbidity, were not significantly associated with postoperative DVT (Table 1).

A χ^2 test was performed to identify the association between disease classification and DVTs, both pre- and postoperatively. There was no significant difference between the disease classification and the occurrence of preoperative DVT. However, the incidence rate of postoperative DVT had a tendency to be lower in degenerative spinal diseases than that of the other 4 classification groups ($P = 0.054$).

DISCUSSION

A prospective follow-up study of patients undergoing spinal surgery was conducted for the purpose of evaluating the perioperative incidence of VTE and the effectiveness of an institutional protocol for VTE without using chemoprophylaxis after the surgery. Preoperative VTE was identified in 4.3% of patients, including one patient with PE on proximal DVT. Despite prophylaxis for DVT with an institutional protocol, new-onset VTE after spinal surgery was found in 6.7% of patients, including 2 patients with PE on proximal DVT who had postsurgical neurological deficit. The follow-up ultrasonographic assessment of this study showed that the DVT disappeared in 85% of patients with distal type DVT without using anticoagulant agents.

The incidence of DVT has been reported to be variable depending on the method of surveillance, DVT prophylaxis, and the postsurgical surveillance period (see review in Glotzbecker *et al*[2]). In a prospective cohort study, Oda *et al*[20] reported the rates of DVT in patients without prophylaxis. Using venographic surveillance, they reported that 15.5% (17/110) developed DVTs within 14 days after surgery (average, 7.2 d). Ferree *et al*[5] reported the incidence of postoperative DVT using compression stockings for primary prophylaxis. Ultrasonographic surveillance within 2 weeks after surgery showed a rate of postoperative DVT of 6%. In another report, Ferree and Wright[6] compared the rate of DVT between methods of prophylaxis using compression stockings, or PSCD combined with compression stockings. They concluded that intermittent pneumatic compression significantly reduced the rate of postoperative DVT.

Previous reports using ultrasound for DVT surveillance show that the rate of DVT in patients undergoing spinal surgery was in the range from 0% to 2.6% when using PSCD and compression stockings as the primary method of prophylaxis,[6,21–24] except for one exceptional report showing that the rate of DVT was 14% (6/41) in a small patient study with a high percentage of high-risk patients.[25] In our study, the incidence of postoperative DVT with proximal DVT, including PE, was 6.7%, relatively higher than previously reported.[6,21–24] One reason may be that in many previous studies,[6,21–24] the existence of DVT was examined in the lower extremity mainly from the iliac vein to the popliteal vein, suggesting that DVT surveillance was performed to detect proximal type DVT. However, distal type DVT (calf muscle DVT) has also been shown to be of great clinical importance because it has the possibility to progress to proximal DVT and result in PE (see review in Masuda *et al*[26]). In our study, examination of DVT was routinely performed from the iliac vein to the calf muscle vein for the purpose of detecting not only proximal DVT, but also the distal type. Indeed, except for the 3 cases of proximal DVT, most DVTs detected were the distal type, found in either the soleus or peroneal vein. Therefore, the inclusion of distal DVTs in the DVT surveillance resulted in the higher ratio of DVT in this study than in previous reports.

Sikorski *et al*[27] reported the natural history of DVT diagnosed by scanning the leg for iodine 123–labeled fibrinogen after total-hip replacement. They found that the peak onset of DVT is on day 4 after surgery. Yamaguchi *et al*[3] examined the incidence of asymptomatic DVT 1, 4, and 14 days after total-joint arthroplasty, and reported that the incidence of DVTs was highest on postoperative day 4, and significantly reduced on postoperative day 14. In our study, postoperative DVT surveillance was performed within 4 days after surgery. In accordance with the previous reports after joint surgery,[3,27] the average day for first detection of postoperative DVTs in our study was 4.75 days. In many previous studies,[6,22–24] DVT surveillance was performed on or after 4 days postoperatively; our earlier surveillance time after surgery would also result in a higher rate of DVT.

In 2 studies where preoperative DVT was evaluated in patients undergoing spinal surgery,[5,6] the reported frequency of preoperative DVT was 1.2% (1/86[5] and 2/185[6]). In contrast, our frequency of preoperative DVT was higher. Similar to the rate of postoperative DVT, DVT surveillance including both proximal and distal type resulted in the higher rate of DVT in this study than in previous reports.[5,6]

For the first time, we report follow-up results of ultrasonographic surveys for DVTs after spinal surgery. Three cases of PE with proximal DVT were successfully treated with anticoagulation therapy, and the absence of DVT was confirmed during the follow-up period. No progression and disappearance of distal type DVT was seen in 85% of patients without anticoagulation therapy after surgery. The thrombi in calf muscle veins (distal DVT) have been reported to be associated with progression into proximal DVT (proximal to popliteal vein) and/or PE.[28,29] MacDonald *et al*[30] reported the natural history of isolated calf muscle vein thrombosis without any treatment, and found that the progression (propagation) of thrombi to the popliteal level was 3%. Because the frequency of progression into proximal DVT and/or PE is low, treatment of distal DVT remains controversial (see review in Masuda *et al*[26]). In a randomized control study, Schwarz *et al*[31] reported that the frequency of progression (propagation) of calf muscle vein thrombosis into the proximal DVT was not significantly different between those treated with LMWH compared with those treated with compression stockings only. On the contrary, in a previous prospective cohort study at the same institution, Schwartz *et al*[32] reported that the progression (propagation) of calf muscle vein thrombosis was significantly prevented by using LMWH. The number of patients with high risk of DVT (such as patients with cancer or ongoing immobilization) was higher in the previous study[32]; they conclude that anticoagulation therapy is not necessary for patients with low-risk of DVT. In our study, although no progression of distal DVT to proximal lesion was identified under the institutional protocol, follow-up DVT surveillance after surgery would be important for detecting the progression of distal DVTs.

The eighth American College of Chest Physicians Conference on Antithrombotic and Thrombolytic Therapy suggested possible thromboembolic risk factors in patients undergoing spinal surgery to include advanced age, malignancy, presence of neurological deficit, previous VTE and an anterior surgical approach.[1] In our study, preoperative patients with DVT were significantly older than those without preoperative DVT. Furthermore, there was a significant trend showing that hypertension may be associated with the presence of preoperative DVT. However, sex, BMI, and comorbidities, including diabetes and heart disease, were not significant risk factors related to DVT.

Proximal type DVT in the 2 cases of patients with PE postoperatively may have occurred as a result of the prolonged immobility resulting from the postsurgical neurological deficit. The eighth American College of Chest Physicians guidelines recommends thromboprophylaxis, including postoperative low-dose unfractionated heparin, LMWH, or the optimal use of perioperative intermittent pneumatic compression for patients undergoing spine surgery who have additional thromboembolic risk factors.[1] On the contrary, the North American Spine Society Clinical Guideline (Antithrombotic Therapies in Spine Surgery) reported that the utility and safety of chemoprophylaxis have not been thoroughly studied even in high-risk patients undergoing spinal surgery for traumatic or neoplastic conditions. Close neurological monitoring is recommended for the use of chemoprophylaxis because of the hazard of hematoma.[33] The results of our study suggest that, even with the utilization of PSCD and compression stockings, chemoprophylaxis would be recommended for high-risk patients with traumatic or neoplastic conditions.

The results of this clinical study suggest the importance of DVT surveillance by ultrasonography during the perioperative period of spinal surgery. However, in a particular clinical field, depending on the institution, it would be difficult and require great care to perform pre- and postoperative DVT surveillance on all patients undergoing spinal surgery. Therefore, for preoperative patients, we recommend checking for DVTs for the elderly and for those patients with comorbidity cardiovascular disorders, such as hypertension. For postoperative patients, we would like to highly recommend performing DVT surveillance, especially for the patients with difficulty in postoperative ambulation because of neurological deficit and/or postoperative pain.

CONCLUSION

DVT assessment using ultrasonography is important for proper management of VTE during the perioperative period of spinal surgery, especially for high-risk patients, such as those with advanced age (those with comorbidity) or neurological deficit. The follow-up results show that Mie University Hospital protocol for DVT using PSCD and compression stockings is effective for most patients with distal type DVT. However, postoperative administration of chemoprophylaxis should be considered for high-risk patients, such as those with spinal tumor or spinal trauma.

➢ Key Points

- ❑ Eleven percent of patients (preoperative: 4.3%, postoperative: 6.7%) undergoing spinal surgery had venous thromboembolic diseases.
- ❑ Pulmonary embolism developed in patients undergoing spinal tumor and spinal trauma (1.0% of total) after spinal surgery.
- ❑ The results of follow-up ultrasonographic assessment showed that 85% of distal type DVT improved with the institutional protocol using both a PSCD and standard compression stockings, and early postoperative ambulation.
- ❑ The administration of chemoprophylaxis should be considered for high-risk patients, such as those with spinal tumors and spinal trauma.

Acknowledgments

Drs. Akeda and Matsunaga contributed equally to the manuscript.

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