Deep Vein Thrombosis and Pulmonary Embolism After Spine Surgery: Incidence and Patient Risk Factors

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Abstract

Anticoagulation after spine surgery confers the unique risk of epidural hematoma.

We sought to determine the incidence of and patient risk factors for deep vein thrombosis (DVT) and pulmonary embolism (PE) after spine surgery. We retrospectively reviewed the charts of 1485 patients who had spine surgery at a single tertiary-care center between 2002 and 2009. DVT and PE incidence were recorded along with pertinent patient history information. Univariate and multivariate analyses were performed on the data.

VTE incidence was 1.1% (DVTs, 0.7%; PEs, 0.4%). Univariate analysis demonstrated that VTEs had 9 positive risk factors: active malignancy, prior DVT or PE, estrogen replacement therapy, discharge to a rehabilitation facility, hypertension, major depressive disorder, renal disease, congestive heart failure, and benign prostatic hyperplasia ($P<.05$). Multivariate analysis demonstrated 4 independent risk factors: prior DVT or PE, estrogen replacement therapy, discharge to a rehabilitation facility, and major depressive disorder ($P>.05$).

Surgeons with an improved understanding of VTE after spine surgery can balance the risks and benefits of postoperative anticoagulation.

Venous thromboembolic events (VTEs), including deep vein thrombosis (DVT) and pulmonary embolism (PE), are serious and potentially life-threatening complications of surgical procedures. DVTs and PEs are uncommon after spine surgery. A recent meta-analysis found a DVT rate of 1.09% and a PE rate of 0.06%.[1] Management of postoperative DVTs and PEs is difficult in spine surgery patients because of the risk for spinal epidural hematoma (SEH).

SEH is a severe but rare complication. Its incidence after spine surgery is 0.1% to 3%.[2] High-dose anticoagulation in the postoperative spine surgery patient with a PE may increase the risk for SEH. Thus, any treatment plan for a spine surgery patient with a postoperative VTE must balance the risk for SEH with the benefit of anticoagulation. Most treatment algorithms for DVT and PE call for high-dose boluses and therapeutic doses of high-molecular-weight heparinoids. Bleeding complications of anticoagulant use have a predictable dose-response curve.[3] Thus, management of a postoperative DVT or PE may pose an SEH risk significantly higher than that posed by routine low-dose chemoprophylaxis. It is important to note that routine use of high-molecular-weight heparinoids has been shown to be safe in postoperative spine surgery patients.[4]

Despite the regulatory[5] and specialty society[6] focus thromboembolic events, there are no clear guidelines for identifying good spine surgery candidates for chemoprophylaxis—because of increased risk, whether from surgical factors or patient factors—or for managing postoperative DVTs and PEs in spine surgery patients. The American College of Chest Physicians guidelines[7] (**Table I**) are unclear on several points. In particular, patient risk factors (ie, factors that put patients at high risk for VTE) have not been studied in detail. Although VTE is rare in spine surgery patients, significant research is warranted to more clearly delineate these issues.

We conducted a retrospective study to determine the spine surgery patient risk factors for VTEs at an elective spine surgery practice. Here we report on the incidence of and patient risk factors for DVT and PE in a general, mostly nontraumatic spine practice. All types of surgeries were included, and relative risk (RR) factors were calculated. Our overall goal was to expand the knowledge base regarding the type of patients at increased risk for postoperative DVT and PE.

Materials and Methods

After obtaining institutional review board approval, we reviewed all 1485 cases of spine surgery performed at our tertiary-care center between 2002 and 2009. The surgeries were performed by 2 spine fellowship-trained surgeons (JRB and WDY). These surgeries addressed the cervical, lumbar, and

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Table I. American College of Chest Physicians Recommendations for Spine Surgery,[7] February 2012

Patient Category	Details	Recommendations
Spine surgery patients	—	Mechanical prophylaxis, LDUH, or LMWH
High-risk patients undergoing spine surgery	Malignant disease Combined anterior-posterior approaches	Pharmacologic prophylaxis after adequate hemostasis is achieved
Major trauma patients	Spinal cord injury Spine fracture requiring surgery	Pharmacologic plus mechanical prophylaxis
	Contraindication to pharmacologic prophylaxis	Mechanical prophylaxis Add LDUH or LMWH when risk for bleeding normalizes Do not use inferior vena cava filter for VTE prevention

Abbreviations: LDUH, low-dose unfractionated heparin; LMWH, low-molecular-weight heparin; VTE, venous thromboembolism.

Table II. Spine Procedures Performed

Type of Procedure	*n*
Cervical	**352**
Posterior cervical decompression	3
Anterior cervical fusion/arthroplasty, 1 or 2 levels	216
Anterior cervical fusion, >2 levels	65
Posterior cervical fusion	53
Combined anterior/posterior cervical fusion	15
Thoracic	**24**
Thoracic fusion by thoracotomy	15
Posterior thoracic fusion	9
Lumbar	**970**
Diskectomy/1-level lumbar decompression	329
Multilevel lumbar decompression	25
Anterior lumbar fusion	35
Posterior lumbar fusion, 1 or 2 levels	388
Posterior lumbar fusion, 3-5 levels	146
Posterior thoracolumbar fusion, >5 levels	41
Lateral lumbar fusion	3
Combined anterior/posterior lumbar fusion	3
Other	**139**
Interspinous process insertion	67
Kyphoplasty	31
Miscellaneous	41
Total	**1485**

thoracic regions and used anterior and posterior approaches (**Table II**). Charts were reviewed for pertinent data, including age, body mass index (BMI), past medical history, medications, smoking history, specific spine procedure, type of DVT prophylaxis, length of hospital stay, DVT or PE diagnosis, and admission to a rehabilitation facility. At our institution, routine prophylaxis involves having patients wear thigh-high compression stockings with sequential compression devices (SCDs) during and after surgery. We investigated all VTEs that had been the subject of clinical suspicion during the hospital stay or at routine follow-ups; there was no routine screening. All VTEs were diagnosed with ultrasonography, ventilation-perfusion quotient scan, or chest computed tomography (CT) with contrast. DVT incidence and PE incidence were calculated for this population group. Possible risk factors—including age, sex, obesity, history of thromboembolism, active malignancy, other comorbidities, prolonged hospital stay or rehabilitation, and smoking—were evaluated for their association to VTEs. Obesity was defined as BMI higher than 30 and active malignancy was defined as a cancer undergoing treatment.

Descriptive characteristics for the cohort were compiled. Means and standard deviations were calculated. Logistic regression analyses were performed to determine the association of comorbidities and other factors with DVT and PE occurrence. Binomial univariate logistic regression was used to analyze age, sex, BMI, prior VTE, comorbidities, and smoking status for an association with VTE occurrence. Variables found to be potentially predictive of the outcome variable from the univariate model ($P<.2$) were included in the multivariate logistic regression models. Multivariate models were used to assess the statistical significance of each individual variable while adjusting for other covariates. Variables found to be nonsignificant ($P>.05$) were removed from the multivariate model in sequential fashion starting with the variable with the highest P. For each variable, RRs and 95% confidence intervals were calculated. SPSS Version 18.0 (SPSS, IBM, Chicago, Illinois) was used for all statistics.

Results

Of the 1485 patients who had spine surgery between 2002 and 2009 (**Table II**), 817 were women (55%) and 668 men (45%).

Mean (SD) age was 53 (14) years (range, 16-103 years). Sixteen patients (1.1%) had at least 1 VTE. Eleven (0.7%) had a DVT and 6 (0.4%) had a PE; 1 patient (0.1%) was formally diagnosed with both. No patient died from a VTE.

Univariate RR calculations demonstrated that prior DVT or PE, active malignancy, estrogen replacement therapy (ERT), discharge to a rehabilitation facility, major depressive disorder (MDD), hypertension, renal disease, congestive heart failure, and benign prostatic hyperplasia were risk factors for postoperative VTEs (P≤.05) (**Table III**). Smoking, multiple procedures within 30 days, obesity, sex, gastroesophageal reflux disease, hyperlipidemia, and sleep apnea were not significant risk factors (P>.05). Multivariate analysis demonstrated that prior DVT or PE, discharge to a rehabilitation facility, ERT, and MDD were independent risk factors (P>.05) (**Table IV**).

Discussion

Venous stasis, endothelial injury, and hypercoagulable states all contribute to the postoperative development of DVT. It is thought that in total knee and hip arthroplasty, direct injury to the large vessels in the leg contributes to the high rates of DVT and PE in the absence of postoperative chemoprophylaxis.[8] In major spine surgery, prolonged immobilization and bone work may contribute to increased risk for postoperative DVT, but direct endothelial injury generally does not. Anterior spine surgery may be an exception. Other investigators have analyzed surgical risk factors that may play a role in DVT and PE after spine surgery. A recent review of 14,932 cases found routine use of chemoprophylaxis was not necessary in posterior-only spine surgery.[8] It may be considered in anterior spine surgery, which involves manipulation of the great vessels. Aside from surgical risk factors, patient risk factors may also contribute to risk for postoperative VTE.

Use of chemoprophylaxis in spine surgery is controversial. In elective spine surgery, DVT prophylaxis must be balanced against the risks for postoperative bleeding and epidural hematoma.[9] Epidural hematoma is a unique complication of spine surgery.[8] The incidence of symptomatic epidural hematoma causing neurologic compromise requiring surgery is between 0.1% and 3%.[8] The result can be a permanent neurologic deficit, such as paralysis.[2,8,10] Despite the apprehension toward chemical anticoagulation, Awad and colleagues[4] found no increased risk for developing an epidural hematoma with use of chemical prophylaxis in a retrospective review of 14,932 spine surgery patients.[9] However, symptomatic epidural hematoma has been reported with therapeutic-dose chemical anticoagulation.[10] Blood loss and wound complications are also associated with chemical prophylaxis.[11] Mechanical prophylaxis methods, specifically use of SCDs alone, have effectively reduced DVT and PE incidence.[12] Experience with VTEs has led some adult spine deformity surgeons to routinely use chemoprophylaxis after surgery. However, most spine surgeons use only mechanical prophylaxis methods in elective spine surgery.[13,14] It is clear that more work is needed to delineate which surgical and patient factors increase the risk for VTE in the postoperative spine surgery patient.

Table III. Univariate Analysis of Patient Risk Factors

Risk Factor	RR	CI	P<
Active malignancy	8.9	2.1-37.0	.001
Prior DVT or PE	8.3	1.3-46.3	.018
Estrogen replacement therapy	6.2	1.4-26.1	.01
Discharge to rehabilitation facility	20.8	1.3-5.2	.018
Hypertension	7.7	1.2-48.2	.023
Major depressive disorder	9.5	2.5-35.9	.001
Renal disease	10.2	1.7-55.5	.007
Congestive heart failure	10.2	1.7-55.5	.007
Benign prostatic hypertrophy	6.6	1.1-37.7	.041

Abbreviations: CI, confidence interval; DVT, deep vein thrombosis; PE, pulmonary embolism RR; relative risk.

Table IV. Multivariate Analysis of Patient Risk Factors

Risk Factor	RR	CI	P<
Prior DVT or PE	2.4	1.8-60.7	.026
Estrogen replacement therapy	3.1	3.5-128.8	.007
Discharge to rehabilitation facility	2.9	2.4-40.3	.002
Major depressive disorder	1.7	1.1-24.7	.040

Abbreviations: CI, confidence interval; DVT, deep vein thrombosis; PE, pulmonary embolism; RR, relative risk.

In this study, we identified some patient risk factors for VTE after spine surgery. The statistically significant risk factors for DVT were prior DVT or PE, ERT, and MDD. Discharge to a rehabilitation facility was a statistically significant variable. Other studies have implicated hypercoagulable states as a risk factor for DVT,[4] so it is not surprising that prior DVT or PE was a risk factor in this study. It is important to note that our center does not treat patients with metastatic cancer on a regular basis. Thus, this significant risk factor may be excluded from our results largely because of institutional selection bias. ERT has also been implicated as a risk factor for DVT and PE in other studies.[15] Discharge to a rehabilitation facility as a risk factor is notable but may be more of a reflection on the size of the surgical procedure than on patient characteristics. For instance, larger spinal fusion procedures with slow patient mobilization may have led to prolonged recumbency and the need for more rehabilitation. Thus, this risk factor may be a reflection of venous stasis. MDD as a risk factor may also reflect prolonged recumbency. It may also reflect the use of various antidepressants. Further investigation along those lines is warranted.

This study had a few limitations. It was retrospective and did not use routine screening to identify patients with VTE. Thus, the 1% incidence likely underestimates the actual in-

cidence that might be found with prospective screening of postoperative spine surgery patients. Furthermore, the hospital patient population used in this study did not include many patients with spinal trauma or metastatic spine tumors. Thus, our conclusions are limited by institutional selection bias. More work at major spinal trauma centers and cancer centers is needed to delineate patient risk factors for VTE.

We have described patient risk factors for postoperative VTEs. Further work is needed to more clearly delineate patient risk factors for VTEs after spine surgery.

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