

## Deep Vein Thrombosis After Complex Posterior Spine Surgery: Does Staged Surgery Make a Difference?

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### Abstract

**Study Design:** Retrospective review of a prospectively collected database.

**Objective:** To assess the incidence of deep vein thrombosis (DVT) associated with single- versus multistage posterior-only complex spinal surgeries.

**Summary of Background Data:** Dividing the physiologic burden of spinal deformity surgery into multiple stages has been suggested as a potential means of reducing perioperative complications. DVT is a worrisome complication owing to its potential to lead to pulmonary embolism. Whether or not staging affects DVT incidence in this population is unknown.

**Methods:** Consecutive patients undergoing either single- or multistage posterior complex spinal surgeries over a 12-year period at a single institution were eligible. All patients received lower extremity venous duplex ultrasonographic (US) examinations 2 to 4 days postoperatively in the single-stage group and 2 to 4 days postoperatively after each stage in the multistage group. Multivariate logistic regression was used to assess the independent contribution of staging to developing a DVT.

**Results:** A total of 107 consecutive patients were enrolled—26 underwent multistage surgery and 81 underwent single-stage surgery. The single-stage group was older (63 years vs. 45 years;  $p < .01$ ) and had a higher Charlson comorbidity index ( $2.25 \pm 1.27$  vs.  $1.23 \pm 1.58$ ;  $p < .01$ ). More multistage patients had positive US tests than single-stage patients (5 of 26 vs. 6 of 81; 19% vs. 7%;  $p = .13$ ). Adjusting for all the above-mentioned covariates, a multistage surgery was 8.17 (95% CI 0.35-250.6) times more likely to yield a DVT than a single-stage surgery.

**Conclusions:** Patients who undergo multistage posterior complex spine surgery are at a high risk for developing a DVT compared to those who undergo single-stage procedures. The difference in DVT incidence may be understated as the multistage group had a lower pre- and intraoperative risk profile with a younger age, lower medical comorbidities, and less per-stage blood loss.

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**Keywords:** Staged surgery; Corrective surgery; Deep vein thrombosis; Spinal fusion; Complications

### Introduction

Complex spine surgery introduces a significant physiologic insult to patients and subjects them to increased risk for intra- and postoperative complications. Dividing the physiologic burden over two or more separate surgeries has been suggested as a potential means of improving the safety of surgery and reducing perioperative complications.

Deep vein thrombosis (DVT) is a particularly worrisome surgical complication owing to its potential to lead to a life-threatening pulmonary embolism (PE) [1]. A meta-analysis of elective spine surgeries for degenerative conditions calculated a DVT rate of 1.4% [2]. It may be theorized that the incidence of DVT is greater with multistaged surgeries, but this has not been reported in the literature.

For surgeons and patients weighing the relative pros and cons of a lengthy single-staged spine surgery versus a multistaged procedure, an honest assessment of the risks and benefits is necessary. Without knowledge about the relative risk of DVT, evidence-based judgments as to the optimal approach for a given patient is not possible. Unfortunately, the incidence of DVT with staged posterior-only spine surgery has not been reported. The purpose of this study, therefore, was to perform a prospective

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assessment of the incidence of DVT associated with single-versus multistage posterior-only complex spinal surgeries.

## Materials and Methods

The authors retrospectively reviewed a prospectively collected database of complex spine surgeries performed by one of two surgeons over a 12-year period (2003–2014) at a single institution. Included in the database were consecutive patients undergoing posterior-only spinal reconstruction procedures lasting greater than five hours and procedures separated into multiple stages separated by no more than 14 days. Anterior or combined anterior/posterior procedures were not included. Patients with surgical indications of cancer or infection were excluded. Surgeries involving principally the cervical spine were also excluded. Institutional review board approval for the study was obtained from the Mercy Medical Center.

Two groups of patients were established: the control group, patients who underwent a single-stage surgery lasting five hours or more, and the case group, patients who underwent planned multistage surgery. All patients discontinued the use of nonsteroidal anti-inflammatories and aspirin at least 10 days prior to surgery.

Standard DVT prophylaxis was administered to all patients in both groups. For patients in both groups, bilateral thigh-high thromboembolic stockings (TEDS) were applied in the preoperative area and maintained throughout the hospitalization. The TEDS were discontinued only after hospital or rehab discharge. In addition, pneumatic sequential compression devices (PSCD) were utilized in both groups during surgery and while nonambulatory during the in-hospital postoperative period. Patients in both groups were encouraged to stand and ambulate on postoperative day 1. On occasion when fixation placed during stage one was temporary and not stable, patients were bed-bound until subsequent stages; in these cases, surgeries were staged no more than one week apart. Chemoprophylaxis such as aspirin or heparin was not utilized.

Every patient was examined for the development of postoperative DVT. The prospective DVT screening protocol involved a lower extremity venous duplex ultrasonographic (US) examination by the same radiology team 2 to 4 days postoperatively in the control group and 2 to 4 days postoperatively after each stage in the case group. Each US was interpreted by the radiologist.

Patient demographic, medical, and DVT risk-factor data were collected prospectively through direct patient interviews and chart review, and was maintained in a prospective longitudinal database. Diagnoses were split into five groups: spondylolisthesis low (grades I–III), spondylolisthesis high (grades IV/V), scoliosis, kyphosis, and disc degeneration/nonunion. Spondylolisthesis was graded based on the Meyerding system [3].

DVT incidence was assessed on a per-person basis, not per-stage. If a patient had one or more positive US

screenings, they were analyzed as having acquired a DVT. Multiple positive reads within the same patient was not considered during analysis. If a second duplex demonstrated an expanded DVT or an additional DVT, this was still considered a single positive DVT for the given patient. Confirmation of a known chronic DVT was not considered positive.

Statistical analysis was done with RStudio, version 0.98.1091. Continuous variables were analyzed using Welch *t* tests. Two-by-two contingency tables were analyzed using Fisher exact tests if any cell value was less than 10, and Pearson chi-squared tests with Yates continuity correction if all cell values were greater than or equal to 10. An alpha of  $\leq 0.05$  was considered statistically significant.

Multivariate logistic regression was used to assess the independent contribution of cofactors to DVT risk. The model controlled for multistage surgery, age, body mass index (BMI), Charlson comorbidity index, prior DVT, smoking cigarettes within one year of surgery, postmenopausal hormone replacement therapy or oral contraceptive use at the time of surgery, renal dysfunction as indicated by creatinine levels of  $> 1.4$  mg/dL at the time of the US exam, active malignancy, and diagnosis. Statistical significance was achieved if 95% confidence intervals did not contain 1.

A second multivariate logistic regression was used to assess the independent contribution of cofactors to DVT risk in patients with spine deformities (scoliosis or kyphosis).

## Results

One hundred seven consecutive patients were assigned to the two groups based on the inclusion criteria. Twenty-six patients underwent multistage surgery. Eighty-one patients underwent single-stage surgery.

Patients undergoing multistage surgery were on average significantly younger (45 years, range 14–81, vs. 63 years, range 14–88,  $p < .01$ ). Consistent with younger age, the multistage group had a lower Charlson comorbidity index (1.23 vs. 2.25,  $p < .01$ ) (Table 1). All other demographics and risk factors were similar between groups: percentage of females, BMI, prior DVT, percentage smoking cigarettes within 1 year of surgery, ongoing postmenopausal hormone replacement therapy or oral contraceptive use, and renal dysfunction (Table 1).

A similar percentage of patients underwent surgery for scoliosis in the multistage group (20%) and the single-stage group (31%) ( $p = .81$ ) (Table 2). There were 11 patients (14%) in the single-stage group with a surgical indication of disk degeneration/nonunion and none in the multistage group ( $p = .06$ ). More patients in the single-stage group were operated on for kyphosis (36%) than in the multistage group (12%) ( $p = .03$ ). High-grade spondylolisthesis was diagnosed more frequently in the multistage group (62% vs. 1%,  $p < .01$ ), whereas low-grade spondylolisthesis was

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