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Higher Incidence of Thrombotic Complications in Thoracic Spine Surgery

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ABSTRACT

Background: Past studies have examined individual complication rates for cervical, lumbar, and thoracic spine surgery but have typically focused on just 1 region of the spine, making comparisons across spine regions difficult. The purpose of the present study was to analyze the incidence of 5 thrombotic complications, including pulmonary embolism, deep vein thrombosis, myocardial infarction, cardiac arrest, and stroke/cerebrovascular accident, across surgical procedures that target different regions of the spine, including cervical, thoracic, and lumbar.

Methods: We conducted a cross-sectional clinical analysis of these 5 thrombotic complications in a relatively large sample. Archival records from the National Surgical Quality Improvement Program database were retrieved and analyzed. We identified 7160 patients in the clinic population who underwent elective cervical, thoracic, or lumbar spine surgery. The records contained diagnoses of each of the 5 thrombotic complications made by a board-certified physician applying American Medical Association assessment procedures.

Results: Findings indicated that the incidence of overall thrombotic complications was relatively low, with only 0.92% of patients (66 of 7160) having any complication. The complication rates differed by type and surgical region of the spine, such that thoracic procedures resulted in a greater percentage of complications ($\chi^2(1) = 14.83$, $P < 0.001$) than cervical or lumbar procedures. Pulmonary embolism in particular occurred with greater likelihood in thoracic procedures and relatively lower likelihood in cervical and lumbar procedures ($\chi^2(1) = 16.43$, $P < 0.001$).

Conclusions: Thoracic surgeries pose the greatest risk for thrombotic complications. Of the thrombotic complications that may occur during thoracic surgeries, pulmonary embolism is the most common.

Clinical Relevance: These findings highlight the need for surgeons to pay particular attention to the risk of certain complications when performing surgeries in specific regions of the spine.

Level of Evidence: 4.

Complications

Keywords: cardiac arrest, complications, deep vein thrombosis, myocardial infarction, pulmonary embolism, stroke

INTRODUCTION

Researchers have studied various thrombotic complications, including pulmonary embolism (PE), deep vein thrombosis (DVT), myocardial infarction (MI), cardiac arrest (CA), and stroke/cerebrovascular accident (CVA). These studies often focus on a single complication, rely on relatively small samples, focus on very specific demographic patient populations, and/or focus on just 1 targeted region of the spine (eg, lumbar).[1–6] The current study aims to determine the likelihood of 5 thrombotic complications in a relatively large demographically broad sample across the 3 major regions of the spine: cervical, thoracic, and lumbar.

Several studies have focused intensely on individual complications, such as analyses of perioperative CVA following spine surgery.[1] This study included 167,106 patients from the Diagnostic Procedure Combination database in Japan and focused on the incidence of perioperative CVA during hospitalization after spine surgery. A second study focused on the incidence of DVT after spine surgery.[2] These researchers studied 41 patients after major adult spine surgery using pedicular or segmental instrumentation. Other studies have examined the prevalence of PE during spine surgery. For example, 1 study included 4179 patients who had undergone spine surgery.[6] These studies and others detailing individual complication rates following spine surgery are valuable, but they addressed just 1 type of complication.

A handful of studies have examined a larger number of complications. For instance, researchers examined 3 perioperative thrombotic complications (PE, DVT, and MI) among 1077 patients in relation to lumbar surgery.[7] Another study estimated the incidence of 4 complication among 13,660 patients who received spine surgery.[8] These studies are compelling because they compared a

variety of complications yet do not include all 5 of these thrombotic complications.

All of these studies focused on various complications following spine surgery. They also differ in the constitution and size of their samples. Also, existing studies often focus on very specific patient populations. For example, one study examined the rate of all 5 complications among a population of more than 12,000, but it focused solely on veterans.[9] Thus, it remains unclear to what extent the data generalize to broader patient populations.

Further limiting the literature findings, some studies often focus on just 1 region of the spine. For instance, 1 study recorded the 5 complication rates of interest for 23,102 patients following 1- or 2-level lumbar decompression and lumbar fusion spine surgeries.[10] This study gathered information about patients from a multicenter database, the American College of Surgeons-National Surgical Quality Improvement Program (NSQIP), which allowed for broad sampling. Findings from these types of studies are compelling and useful; however, they focus on complications after a specific surgery that targets a single region of the spine.

Possibly because of the various sample sizes, the focus on specific populations, or the focus on specific regions of the spine, a range of complication rates has been documented in the literature. Although each study has tremendous value, the literature lacks a single study that comprehensively examines all 5 complication rates in a relatively large sample, across surgical procedures that target different regions of the spine, including cervical, lumbar, and thoracic. Thus, the present study, which utilized data from the NSQIP database, sought to provide a comprehensive examination the 5 complication rates.

METHODS

Our hypothesis was that thrombotic complications would occur most frequently in thoracic regions of the spine, as thoracic procedures are typically longer and more extensive than cervical or lumbar surgeries. This study followed the Strengthening the Reporting of Observations Studies in Epidemiology guidelines.[11]

There were 7342 spine surgery patients in the clinic population secured from the NSQIP database who underwent spine surgery between 2011 and 2017. These patients underwent elective spine surgery at Christiana Hospital in Wilmington, Delaware. From this pool of patients, 165 patients were not analyzed because the surgery did not clearly target a specified region of the spine (cervical, thoracic, and/or lumbar). Furthermore, 17 additional patients were not analyzed because the surgery targeted more than 1 region of the spine. Of the remaining 7160 patients in the final dataset, 51% were women (n = 3654) with a mean age of 56.96 (SD = 13.81) years and a mean body mass index of 30.99 (SD = 7.04). The sample was composed of participants who identified racially as 83% (n = 5948) White, 16% (n = 1118) Black, 1% (n = 63) Asian, 0.3% (n = 24) unknown/unreported, 0.1% (n = 6) American Indian/Alaskan Native, and <0.1% Native Hawaiian or Other Pacific Islander (n = 1). Also, 96% (n = 6897) were non-Hispanic. For the location of surgery, 33% (n = 2384) underwent cervical surgery, ranging from vertebral levels C1 to C7, 3% (n = 249) underwent thoracic surgery ranging from vertebral levels T1 to T12, and 63% (n = 4527) underwent lumbar surgery, ranging from vertebral levels L1 to S1.

Archival data were retrieved from the NSQIP database, and the records were analyzed using IBM SPSS Statistics version 26. The records contained diagnoses of each of the 5 thrombotic complications: PE, DVT, MI, CA, and CVA. Each diagnosis was made by a board-certified physician applying standard American Medical Association assessment procedures.

RESULTS

Findings indicated that the incidence of overall thrombotic complications was relatively low, with only 66 of 7160 total patients (0.92%) having at least 1 complication. The complication rates differed by type (Table) and were 0.41% for PE (29 cases with PE out of a total of 7160 patients), 0.43% for DVT (31/7160), 0.13% for MI (9/7160), 0.10% for CA (7/7160), and 0.10% for CVA (7/7160). Furthermore, complications differed by spinal region targeted: complication rates were 0.76% for surgeries that targeted the cervical spine (18/2384 total cervical procedures), 3.61% for surgeries that targeted the thoracic spine (9/249 total thoracic procedures), and 1.24% for surgeries that targeted the lumbar spine (56/4527 total lumbar procedures).

Several of the specific complications varied according to the targeted region of the spine (Table). For example, PE occurred most frequently in thoracic procedures (2.01%, 5/249 total thoracic procedures) and least frequently in cervical procedures (0.29%, 7/2384 total cervical procedures) and lumbar procedures (0.38%, 17/4527 total lumbar procedures). DVT had a higher incidence in thoracic procedures (1.20%, 3/249 total thoracic procedures) and lower incidence in cervical (0.25%, 6/2384 total cervical procedures) and lumbar procedures (0.49%, 22/4527 total lumbar procedures).

Table. Incidence of thrombotic complications across cervical, lumbar, and thoracic regions.

Region	PE	DVT	MI	CA	Stroke/CVA	Total Complications
Cervical (n = 2384)	0.29 (n = 7)	0.25 (n = 6)	0.04 (n = 1)	0.13 (n = 3)	0.04 (n = 1)	**0.76 (*n* = 18)**
Thoracic (n = 249)	2.01 (n = 5)	1.20 (n = 3)	0.40 (n = 1)	0.00 (n = 0)	0.00 (n = 0)	**3.61 (*n* = 9)**
Lumbar (n = 4527)	0.38 (n = 17)	0.49 (n = 22)	0.15 (n = 7)	0.09 (n = 4)	0.13 (n = 6)	**1.24 (*n* = 56)**
Total (*N* = 7160)	**0.41 (*n* = 29)**	**0.43 (*n* = 31)**	**0.13 (*n* = 9)**	**0.10 (*n* = 7)**	**0.10 (*n* = 7)**	**1.16 (*n* = 83)**

Abbreviations: CA, cardiac arrest; CVA, cerebrovascular accident; DVT, deep vein thrombosis; MI, myocardial infarction; PE, pulmonary embolism.
Note: These 83 complications were experienced across 66 patients.

Other complications were similarly experienced across surgeries that targeted different regions of the spine. For example, the rates of MI were relatively low in all 3 regions of the spine: 0.04% (1/2384 total cervical procedures), 0.40% (1/249 total thoracic procedures), and 0.15% (7/4527 total lumbar procedures). However, MI for thoracic procedures was slightly elevated relative to the others. The rates of CA were also relatively low in all regions: 0.13% (3/2384 total cervical procedures) for cervical, 0.00% (0/249 total thoracic procedures) for thoracic, and 0.09% (4/4527 total lumbar procedures) for lumbar. The rates of CVA followed this same pattern: 0.04 (1/2384 total cervical procedures), 0.00% (0/249 total thoracic procedures), and 0.13% (6/4527 total lumbar procedures).

The overall thrombotic complications were relatively more likely to occur when surgeries targeted thoracic regions (3.21%, 8/249 people who had thoracic procedures experienced at least 1 perioperative thrombotic complication) compared with when surgeries targeted other regions (0.84%, 58/6911 cervical or lumbar patients with at least 1 perioperative thrombotic complication; $\chi^2(1) = 14.83$, $P < 0.001$). For thoracic surgeries, PE was more common (2.01%, 5/249 thoracic patients experienced PE perioperatively) than it was when surgery targeted the cervical or lumbar regions (0.35%, 24/6911 cervical or lumbar patients experienced PE perioperatively; $\chi^2(1) = 16.43$, $P < 0.001$). DVT trended in the same direction, being more likely when surgery targeted thoracic (1.20%, 3/249 thoracic patients experienced DVT perioperatively) vs cervical or lumbar regions (0.41%, 28/6911 cervical or lumbar patients who experienced DVT perioperatively; $\chi^2(1) = 3.57$, $P = 0.059$). The data that correspond to these χ^2 tests are presented in the Table.

DISCUSSION

Our results extend existing research by enabling the comparison of specific complications across surgeries performed on the 3 major regions of the spine. Furthermore, the overall thrombotic complication rates in the current study consistently fell on the lower end of the ranges found in previous studies.[12–16] Specifically, we found that thrombotic complications were more likely when surgeries targeted thoracic regions of the spine, and PE in particular had a higher incidence following surgeries performed on the thoracic spine than surgeries performed on the cervical spine or the lumbar spine. This rate was approximately more than 5 times higher for thoracic surgeries compared with other targeted regions of the spine, perhaps related to the proximity of the thoracic spine to vital organs such as the lungs.[17] Thoracic surgeries also are typically longer and more extensive than cervical or lumbar surgeries, which may increase the risk of surgeries in this region of the spine.

Although the findings from this study may be useful and informative, this study is not without limitations. One limitation is that the spine surgeons at Christiana Hospital used standard American Medical Association diagnostic procedures; therefore, the findings might not generalize to surgeons using broader or narrower approaches. The findings also might not represent the complication rates from spine surgeons who use different precautionary protocols to limit complications. That said, even though these data have limitations, they represent thousands of patients with varying demographic backgrounds. Given that the data are complete across complication types and targeted spine regions, they allow for valid comparisons across these important variables. Although imperfect, the findings here provide details about these 5 thrombotic complications across the 3 different regions of the spine. Findings confirm that thoracic regions are particularly vulnerable to PE. Future work should continue to investigate the strong trend found regarding the risk of DVT within thoracic surgery specifically.

CONCLUSION

We found that the overall rate of thrombotic complications was relatively low when surgeries targeted cervical or lumbar regions. The incidence of any thrombotic complication was significantly greater when a surgery targeted a thoracic region, possibly related to a relatively greater risk for surgeries in the thoracic spine. These findings highlight the need for surgeons to pay particular attention to the risk of certain complications when performing surgeries in specific regions of the spine.

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