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Incidence and risk factors of venous thromboembolism in the perioperative period of spine surgery at a tertiary care hospital

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ABSTRACT

Objectives: Spine surgery is considered a moderate risk for developing venous thromboembolism (VTE). To the best of our knowledge, no study has been done to determine the incidence of VTE in our local population. We aimed to study the incidence of VTE and determine the factors associated with developing VTE post-spine surgery.

Methods: A retrospective study analyzed 800 adult patients who had undergone elective or emergency spine surgery. The variables included were demographic data, diagnosis, "or trauma if applicable," type and duration of surgical intervention, and length of hospital stay. In addition, two procedures were used to diagnose VTE, whether it was a pulmonary embolism (PE) or deep vein thrombosis (DVT) pre- and postoperatively. Spiral computed tomography was used to detect PE, whereas duplex ultrasonography was used to confirm DVT. Finally, all patients received post-operative DVT prophylaxis except for cervical spine patients.

Results: Eight hundred patients were included in the study. The overall incidence of VTE was 4.1%. The lumbar spine was the most common location operated on. Increasing age and length of hospital stay were both significantly associated with the development of VTE. Furthermore, cervical spine surgery had a lower incidence of VTE than other locations, with a statistically significant difference. Finally, non-ambulatory patients had a higher risk of VTE than patients who could ambulate postoperatively, with a statistically significant difference.

Conclusion: The incidence of VTE after spine surgery is considered low but carries high morbidity and mortality rates. Increased age and prolonged hospital stay increase its risk, while early ambulation lowers it. Prophylactic measures against VTE are highly recommended, especially amongst high-risk patients.

Keywords: Anticoagulation, Deep vein thrombosis, Hospital stay, Pulmonary embolism, Spine surgery

INTRODUCTION

Spine surgery has witnessed a dramatic global increase in rate recently. With that increase, the amount of literature describing its post-operative complications has been increasing, with one of

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the devastating complications that are being studied, venous thromboembolism (VTE).[1]

VTE is a clot formation disorder in veins that include both deep vein thrombosis (DVT) and pulmonary embolism (PE), with the most affected veins in DVT being the lower limb veins. It is also known that untreated DVT can precipitate the development and formation of PE, which carries high morbidity and mortality risk, as shown in the literature.[2] In addition, almost half of all untreated DVT cases are complicated by PE.[3]

Various research explored the risk factors for developing VTE, including obesity, prolonged immobilization, old age, and major surgeries such as spine surgery.[4] In addition, numerous studies have also been done to study the epidemiology of VTE, with most showing the incidence ranging from 0.5% to as high as 45%, depending on the location and the type of surgery done.[5-7]

Furthermore, due to the high morbidity and mortality that VTE carries, multiple studies have shed light on the pre- and post-operative measures to decrease and prevent it, including early ambulation and mechanical and chemical anticoagulation, which have all been shown to decrease its incidence.[8]

However, the occurrence of spinal epidural hematoma, which is a unique complication of spinal surgery, makes the management of spinal cases more difficult in the post-operative period. After spine surgery, pharmacoprophylaxis is generally not recommended due to the risk of epidural hematoma, which may cause permanent neurological deficits. Due to the heterogeneous nature of spinal epidural hematoma and the lack of available literature, the use of anti-thrombotic prophylaxis varies depending on the surgeon's preference.[9,10]

There are no local data up to our knowledge looking at the incidence and risk factors of VTE in spine surgery, which was the aim of this study as we believe it, will help improve the measures of decreasing the incidence after shedding light on the risk factors.

MATERIALS AND METHODS

We used a retrospective chart review study in a tertiary hospital setting in Riyadh, Saudi Arabia, between the year 2016 and 2019 to identify the incidence of thromboembolism in the perioperative period of spine surgery. We utilized a conventional sampling technique for which all patients who underwent spine surgery during the study time period were included in the study.

A total of 800 adult patients above 18 years of age who had undergone elective or emergency spine surgery were identified. Multiple variables were analyzed, including demographic data, diagnosis, type and duration of surgical intervention, and length of hospital stay. All patients received post-operative chemical VTE prophylaxis, except for cervical spine patients.

Depending on the patient's medical condition, low-molecular-weight heparin (LMWH) or unfractionated heparin was administered the next morning prophylactically after surgery. All patients received LMWH except those with chronic kidney disease or end-stage renal disease whose unfractionated heparin was received instead. In addition, mechanical VTE prophylaxis, which consists of compressive pneumatic compressors, was also used for the first 24 h after the surgery.

Body mass index (BMI) was measured and calculated based on the WHO classification. BMI <18.5 is considered underweight, 18.5–24.9 is normal weight, 25.0–29.9 is pre-obesity, 30.0–34.9 is obesity class 1, 35.0–39.9 is obesity class 2, and BMI above 40, is obesity class 3.[11]

Furthermore, spiral computed tomography was used to detect PE, whereas duplex ultrasonography was used to diagnose DVT both pre- and postoperatively.

Patients presenting to the hospital with an acute neurological deficit due to spine pathology were screened for DVT by Doppler ultrasound routinely before surgical intervention. In addition, all spine tumor patients were screened for DVT preoperatively, even if they were asymptomatic. Moreover, patients showing signs or symptoms of DVT were investigated at the onset of the symptoms, which consisted of calf swelling, redness, or pain or have not ambulated for 2 days before presentation.

Statistical analysis

All data were collected in an Excel sheet, appropriately coded, and transferred to the Statistical Analysis Software.

Univariate data were analyzed using mean ± standard deviation.

Bivariate data were analyzed using the Chi-squared test to compare categorical data, and *t*-test and analysis of variance to compare means of different groups. Fisher's exact test was used to calculate *P*-value, with a value of <0.05 considered statistically significant.

RESULTS

A total of 800 patients were finally included in our study; 422 (52.8%) were male, with a mean age for all genders being 49.8 ± 18.8 years and a mean BMI of 28.9 ± 7. The most common comorbidity was diabetes mellitus, which was found in 295 (36.9%) patients, followed by hypertension, which was observed in 290 (36.3%) patients [Tables 1 and 2].

Table 1: Basic demographics of patients' population.

Variable	Number	Mean±SD	Percentage
Age	-	49.8±18.8	-
BMI			
Underweight	49	16.23±2.1	6.2
Normal weight	172	21.9±1.8	21.5
Overweight	238	27.5±1.4	29.8
Obesity 1	175	32.3±1.4	21.9
Obesity 2	117	37.2±1.5	14.6
Obesity 3	48	45.6±2.5	6
Gender			
Male	422	-	52.8
Female	378	-	7.2
Site of operation			
Cervical	193	-	24.1
Thoracic	101	-	12.6
Lumbar/sacra	506	-	63.3
Spine pathology			
Degenerative	430	-	53.8
Trauma	167	-	20.9
Infection	100	-	12.5
Deformity	66	-	8.3
Tumor	37	-	4.6

BMI: Body mass index SD: Standard deviation

Table 2: Associated comorbidities amongst all patients' population.

Variable	Number	Percentage
Diabetes mellitus	295	36.9
Hypertension	290	36.3
Dyslipidemia	171	21.4
Ischemic heart disease	14	1.75
Atrial fibrillation	13	1.63
Chronic kidney disease	12	1.5
Liver cirrhosis	2	0.25

There was no epidural hematoma that occurred in our study sample.

The most common site operated was the lumbar spine, followed by the cervical, which included 506 (63.7%) and 193 (24.3%) patients, respectively. Degenerative spine disease was the most common cause of surgery, with 430 (53.8%) patients, followed by trauma, which included 167 (20.9%) patients [Table 1].

Furthermore, the incidence of VTE was 4.1% (33 patients). However, we found that most of these patients developed acute VTE during the pre-operative phase of their illness, with a ratio of pre-operative to post-operative VTE of 2:1 in our series [Table 3].

Moreover, both increasing age and increased length of hospital stay were found to be associated with a higher incidence of VTE, with a statistically significant difference ($P < 0.05$). In contrast, a shorter time to ambulate was found to be associated with a lower incidence of VTE ($P < 0.05$) [Tables 4 and 5].

Table 3: DVT and PE incidence pre- and postoperatively.

Variable	Number	Percentage
Pre-operative DVT	11	1.3
Post-operative DVT	7	0.875
Pre-operative PE	12	1.5
Post-operative PE	6	0.75

DVT: Deep vein thrombosis PE: Pulmonary embolism

Finally, thoracic and lumbar spine surgeries were both associated with a higher incidence of VTE when compared with cervical spine surgeries, with a statistically significant difference ($P < 0.05$).

DISCUSSION

Our study has shown that the incidence of VTE after spine surgery is on the low side of what has been described in the literature.[5-7] Yang *et al.* found an incidence of 15.9% in patients undergoing posterior spinal fusion with no difference between LMWH and non-LMWH groups.[5] On the other hand, Namboothiri conducted a prospective study of 121 patients who underwent major spinal surgeries and found an incidence of 0.78% with no clinically evident PE cases.[7] In the former study, the authors mentioned that the most probable cause for the high incidence was the fact that any patient who had not ambulated on the 7th post-operative day underwent a Doppler ultrasound. In contrast to the latter study, the author mentioned that the low incidence might be attributed to the fact that the sample size was small, in addition to the fact that only symptomatic patients with DVT (such as calf pain, swelling, or redness) had a Doppler ultrasound, as screening every patient was not considered to be cost-effective.

However, in our study, we have elected to screen symptomatic patients in addition to patients who were considered at risk of developing VTE. They included all trauma patients, patients with a neurological deficit at presentation due to the probability of them being non-ambulatory before their emergency department or clinic visit, patients who had not ambulated for 48 h before presentation, and cases of malignancy. The incidence of VTE in our study differs from both studies as we have utilized a similar screening method to the former study with the addition of screening at-risk patients and contained a higher sample size than the latter study.

Epidural hematoma is a serious complication after spine surgery, which may result in spinal paresis. It was reported

Table 4: Odds ratio in developing VTE.

Variable	Standard error	Odds ratio	*P*-value
Age	0.0117	1.024	0.041
Length of hospital stay	0.00341	1.009	0.01
Time to ambulation	0.5217	0.294	0.019
Lumbar versus cervical	0.823	5	0.049
Thoracic versus cervical	0.84	5.9	0.035

VTE: Venous thromboembolism

Table 5: Incidence of VTE in each spine pathology.

Total (800)	Number	Perioperative VTE	Perioperative VTE incidence
Trauma	167	13	7.8
Tumor	37	3	8.0
Degenerative	430	14	3.3
Infection	100	7	7.0
Deformity	66	1	1.5

VTE: Venous thromboembolism

that LMWH prophylaxis seems to be associated with a low risk of hemorrhage when started 24–36 h after spine procedures.[12] It was also demonstrated that no major bleeding events occurred when half a dose of LMWH was administered 6 h after spine surgery, followed by a full dose of LMWH once a day until discharge.[13] These statements may explain the low incidence of VTE postoperatively in our patients, where all patients who underwent thoracic or lumbar surgery had chemical prophylaxis, and no epidural hematoma occurred.

In our study, Doppler ultrasound was done based on the strict policy developed, which is mentioned earlier. Such an approach has enabled us to diagnose more than 2/3 of our positive VTE cases with our routine pre-operative screening protocol before the patient's surgical intervention, thus avoiding potentially fatal complications with the appropriate diagnosis and necessary treatment of VTE in a timely manner.

Moreover, our study has shown that increasing age is a risk factor for developing VTE after spine surgery, which is consistent with most of the literature suggesting the same result.[5,12-14] The mean age in our study was 49.8 ± 18.8 years, which was also consistent with the studies mentioned. Increasing age has been known to cause physiological changes in the human body, including vascular stasis, which is one of Virchow's triads known to increase the risk of developing VTE.[15,16]

Furthermore, we have found that prolonged hospital stay increased the risk of VTE, and we believe that increased hospital stay was the result of delayed ambulation, which, in turn, is the main reason for the increased incidence of VTE. A large study that included more than 800,000 patients also concluded the same result with a three-fold risk increase in DVT for patients with more than 5 days of hospital stay.[17] Furthermore, another study has demonstrated a four-fold increase in the risk of DVT for post-operative spine surgery patients with a hospital stay longer than 6 days.[17]

One of the probable causes for this result is that patients with longer hospital stay did not achieve the ambulation goal early and, hence, resulted in a longer low ambulation period, which is also an important factor as our study found that early ambulation decreases the risk of developing VTE. One study mentioned that increased hospital stay increases the risk of developing VTE as it led to decreased physical activity which affects Virchow's triad.[18]

Finally, patients undergoing cervical spine surgery were found to have a significantly lower risk for VTE than patients who underwent thoracic or lumbar spine surgeries. This result was reported similarly in multiple other studies, even though cervical spine surgery patients did not receive prophylactic anticoagulation to avoid a potentially life-threatening hematoma collection and airway compromise.[19-21]

This is likely to be explained by the fact that the amount of soft tissue and muscle dissection required in the cervical area is lower, which will likely result in less post-operative pain and, thus, a higher chance of early ambulation and shorter hospital stay. In addition, Buchanan *et al.* mentioned that, in patients undergoing thoracolumbar spine surgery, the intraoperative prone position inflects higher compression in the inguinal area, which results in increased lower extremity venous stasis.[19]

This study has some limitations. As with any retrospective analysis, there is a potential for error because of selection bias. Furthermore, the relatively small number of patients, as some nationwide studies included thousands of patients. However, other studies included below 100 patients but were still statistically valid. In addition, no strict comparison between 2 similar groups where one anticoagulated (such as the thoracic and lumbar patient category) could be done. Thus, our findings do not allow us to recommend chemical prophylaxis.

CONCLUSION

The incidence of VTE after spine surgery is considered low. Nevertheless, it is a complication that carries high morbidity and mortality rates, and increased age, in addition to a prolonged hospital stay, increases its risk, while early ambulation lowers it.

ETHICAL APPROVAL

This study was submitted and approved by the Institutional Review Board (IRB) at King Abdullah International Medical Research Center (KAIMRC) on December 17, 2019. IRB number RC19/460/R.

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AUTHORS' CONTRIBUTIONS

FK: Proposal writing supervision and manuscript revision and writing. HA: Data collection and manuscript writing and revision. AA: Data collection and proposal writing. SA: Data collection and proposal writing. RA: Data collection, proposal writing. RuA: Data collection, proposal and manuscript writing and revision. All authors have critically reviewed and approved the final draft and are responsible for the manuscript's content and similarity index.

DECLARATION OF PATIENT CONSENT

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients have given their consent for their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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CONFLICTS OF INTEREST

There are no conflicting relationships or activities.

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