

# Leveraging Digital Platforms to Investigate Deep Vein Thrombosis Frequency among Spinal Surgery Candidates

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## ABSTRACT

**Background:** In recent years, the convergence of medical research and digital technology has opened up new avenues for exploring intricate healthcare dynamics. Deep Vein Thrombosis, a potentially life-threatening condition characterized by the formation of blood clots in deep veins, is of paramount concern for surgical candidates due to the inherent immobilization associated with postoperative recovery. This study aimed to evaluate the utilization of digital platforms for investigating the frequency of Deep Vein Thrombosis among candidates for spinal surgery.

**Methods:** This retrospective study, conducted at Hazrat Rasool Akram (PBUH) hospital, Tehran, Iran between February 2014 and February 2019, investigated Deep Vein Thrombosis (DVT) frequency among spinal surgery candidates using digital platforms. Electronic health records (EHR) were collected and preprocessed, integrating processed data on a secure cloud-based platform for collaborative access and advanced analytics. These records contain comprehensive information about a patient's medical history, diagnoses, medications, treatment plans, immunization dates, allergies, radiology images, and laboratory test results. Collecting EHR involves gathering electronic data from various sources within the hospital database. After examining them, 218 patients were included in the present study. Data analysis entails STATA software, applying descriptive statistics, chi-square tests, and associations between ultrasound findings and clinical variables.

**Results:** The mean age of these patients was  $49.22 \pm 11.22$  years. The frequency of DVT in candidates for back surgery was 1.83%. Regarding D-dimer investigation, the results of our study showed that all 4 patients with DVT had high D-dimer, while only 34 patients of all patients without DVT had high D-dimer levels. The results showed that the presence of the history of hospitalization reduces the risk of DVT in patients who were candidates for back surgery ( $P=0.028$ ), while the high level of serum D-dimer was an important warning sign for the occurrence of DVT in patients who were candidates for back surgery ( $P=0.001$ ).

**Conclusion:** This study showcases the value of digital platforms in investigating Deep Vein Thrombosis frequency among spinal surgery candidates, highlighting the associations between D-dimer levels, medical history, and DVT risk. These findings offer insights that can inform clinical assessments and interventions for this patient population.

**Keywords:** Distance, Education, Online social networking, Venous thrombosis, Spinal cord

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## Introduction

In the realm of healthcare, the fusion of digital technologies and medical research has ushered in a new era of precision medicine and evidence-based practices (1). The incidence of Deep Vein Thrombosis among individuals undergoing spinal surgery has attracted increased attention due to its potential to compromise the patient's safety and postoperative recovery (2). Historically, investigating the frequency of DVT within this specific context has been a complex endeavor, requiring meticulous data collection, robust analysis, and the ability to navigate through a multitude of variables (3).

Digital platforms, with their capacity to aggregate, process, and analyze vast amounts of patient data, have emerged as indispensable tools in unraveling the intricate patterns of DVT occurrence among spinal surgery candidates (4). Electronic health records, wearable devices, and telemedicine applications provide a wealth of information that, when harnessed effectively, can offer a comprehensive view of patients' preoperative risk factors, surgical outcomes, and postoperative complications. The real-time monitoring capabilities of these platforms enable healthcare providers to identify the potential DVT cases early, allowing for timely interventions that could mitigate the severity of the condition (2, 5, 6).

Furthermore, digital platforms facilitate the establishment of large-scale databases that transcend individual healthcare institutions. Collaborative efforts across multiple medical centers can lead to accumulation of extensive datasets, empowering the researchers to conduct more robust epidemiological studies and assess the impact of various preventive measures. Machine learning algorithms and predictive modeling techniques can be applied to this data, aiding in the identification of risk factors, development of personalized prevention strategies, and refinement of surgical protocols (7).

This research can contribute to evidence-based clinical decision-making. By identifying the prevalence of DVT among spinal surgery

candidates, healthcare providers can tailor preoperative assessments and postoperative management strategies to mitigate the risk of thrombotic events. This customization can lead to more effective patient care, reduced complications, and shorter hospital stays. Therefore, this study aimed to leverage digital platforms to investigate the frequency of Deep Vein Thrombosis among candidates for spinal surgery.

## Methods

### *Study Design*

This study was conducted in the form of a retrospective online analysis of patients referred to Hazrat Rasool Akram (PBUH) hospital, Tehran, Iran from February 2014 to February 2019 who were diagnosed with spinal disorders and candidates for surgery. This research employed a multifaceted approach to investigate the frequency of DVT among candidates undergoing spinal surgery, harnessing the capabilities of digital platforms. Initially, electronic health records (EHR) of spinal surgery candidates were obtained from diverse healthcare institutions, encompassing patient demographics, medical history, surgical specifics, and postoperative outcomes. These data were preprocessed, including cleaning, validating, and structuring for compatibility with subsequent analysis. Leveraging a secure cloud-based digital platform, the processed data were integrated, facilitating collaborative access and advanced analytics. Through rigorous feature selection and engineering, pertinent factors influencing DVT occurrence, such as age, medical history, anesthesia type, and mobility post-surgery, were identified and possibly augmented with newly derived risk factors. Central to the digital transformation, a secure cloud-based digital platform was employed. This platform served as the conduit for integrating the processed data, thus facilitating seamless collaboration and enabling advanced analytics. Through this digital medium, the research team gained collaborative access to the amalgamated data, setting the stage for deep insights to

be extracted. The utilization of this platform streamlined data management, bolstered data security measures, and expedited data accessibility, laying the foundation for comprehensive analysis. Within this digital environment, a meticulous process of feature selection and engineering ensued, where pertinent factors that influence DVT occurrence, such as age, medical history, anesthesia type, and post-surgery mobility, were identified. Additionally, the integration of newly derived risk factors augmented the analytical prowess of the investigation.

### *Participants*

Patients were included in the present study. The study included a carefully selected sample of participants based on specific inclusion and exclusion criteria. Participants eligible for inclusion were adults aged 18 years or older. Additionally, participants must comply with the study procedures and have documented medical records with relevant diagnostic information. However, patients who had undergone spinal surgery within the past six months, had a known history of DVT or pulmonary embolism, were unable to provide informed consent, had contraindications to anticoagulation, or had severe comorbidities that might significantly influence study outcomes were excluded.

### *Sampling*

With a 95% confidence level and 80% power, a total of 200 individuals were calculated. Given a 10% potential to increase power, a Margin of Error  $\approx 0.0712$  and  $P < 0.05$ , a minimum sample size of 218 individuals was estimated (6). The study included a carefully selected sample of participants based on specific inclusion and exclusion criteria. In a retrospective study, obtaining informed consent from individual participants may not be feasible or required due to the nature of using pre-existing data or records.

### *Statistical Analysis*

D-dimer diagnostic test was performed for patients suspected of deep vein thrombosis and

all individuals who were in the group without DVT. Once the data was collected, a thorough analysis was conducted to determine the frequency of DVT among the spinal surgery candidate patients. The analysis involves examining the frequency and distribution of DVT cases within the selected patient population. Statistical techniques, such as descriptive statistics and inferential analysis, might be employed to calculate the frequency rates and identify the potential risk factors associated with DVT development. Data analysis was done using STATA software. The design and all stages of the implementation of this study were registered in the research system of the Vice-Chancellor of Research and Technology of Iran University of Medical Sciences. All stages of the project were carried out after obtaining the code of ethics from the ethics committee of Iran University of Medical Sciences. The research team of this study adhered to the ethical principles of the Helsinki Convention regarding clinical studies in all stages of the present study.

Descriptive statistics were used to calculate the mean and standard deviation for age, height, weight, and BMI in both "Normal" and "DVT" groups. The comparison of demographic data between the two groups ("Normal" and "DVT") was performed using statistical tests such as the independent samples t-test or ANOVA. Associations between the ultrasound findings and clinical history were tested using the chi-square test or Fisher's exact test for categorical variables. The association between the ultrasound findings and hematological tests (PTA, FIB, TT, and D-dimer) was tested using the chi-square test or Fisher's exact test. Similar contingency tables and statistical tests (chi-square or Fisher's exact) were employed to examine the association between the ultrasound findings and biochemical tests (HDL, LDL, total cholesterol, Billy Robin Tom, Direct Bilirubin, and Indirect Bilirubin).

### **Results**

Demographic patient data is presented in Table 1.

**Table 1:** Demographic data of patients

Variable	Normal	DVT	Total	P value
Age	49.11 ±4.49	50.47 ±5.11	49.11 ±2.49	0.762
height	170.88 ±2.17	170.00 ±3.1	170.10 ±3.4	0.868
Weight	67.74±4.4	67.75±5.6	67.74 ±5.3	0.212
Body mass index	25.83±4.5	23.52±3.4	25.78±4.7	0.320

**Table 2:** Association between ultrasound findings and clinical history of patients

Variable	Answer	Normal	DVT	Total	P
Hospitalization history	No	86 (39.4)	4 (1.8)	90 (41.2)	0.028
	Yes	128 (58.7)	0 (0)	128 (58.8)	
Employment status	Unemployed	95 (43.5)	3 (1.3)	98 (45)	0.329
	Employed	119 (54.5)	1 (0.4)	120 (55)	
High blood pressure	Does not have	147 (67.4)	4 (1.8)	151 (69.2)	0.315
	Has	67 (30.8)	0 (0)	67 (30.8)	
Diabetes	Does not have	141 (64.7)	4 (1.8)	145 (66.5)	0.303
	Has	73 (33.4)	0 (0)	73 (33.5)	
Spinal epidural hematoma	Does not have	214 (98.2)	4 (1.8)	218 (100)	----
	Has	0 (0)	0 (0)	0 (0)	
Bleeding	Does not have	173 (79.4)	4 (1.8)	177 (81.2)	>0.999
	Has	41 (18.9)	0 (0)	41 (18.8)	
Blood injection	Does not have	184 (84.4)	4 (1.8)	188 (86.2)	>0.999
	Has	30 (13.6)	0 (0)	30 (13.8)	

**Table 3:** The Association between ultrasound findings and hematological tests

Variable	Answer	Normal	DVT	Total	P
Status of PTA	Normal	203 (93.2)	4 (1.8)	207 (95)	>0.999
	Increased	11 (5)	0 (0)	11 (5)	
The status of the FIB	Normal	178 (81.6)	3 (1.3)	181 (83)	0.572
	Increased	36 (16.5)	1 (0.4)	37 (17)	
The status of TT	Normal	201 (92.2)	4 (1.8)	205 (94)	>0.999
	Increased	13 (59.6)	0 (0)	13 (6)	
D-dimer state	Normal	180 (82.5)	0 (0)	180 (82.5)	0.001
	Increased	34 (15.5)	4 (1.8)	38 (17.5)	

**Table 4:** The association between ultrasound findings and biochemical tests

Variable	Answer	Normal	DVT	Total	P
HDL status	Up	22 (10)	0 (0)	22 (10.2)	>0.999
	Normal	175 (80.2)	4 (1.8)	179 (82.1)	
	Down	17 (7.7)	0 (0)	17 (7.7)	
LDL status	Down	13 (6)	0 (0)	13 (6)	>0.999
	Normal	170 (78)	4 (1.8)	174 (79.8)	
	Increased	31 (14.2)	0 (0)	31 (14.2)	
Total cholesterol	Normal	161 (73.8)	4 (1.8)	165 (75.6)	0.574
	Increased	53 (24.3)	0 (0)	53 (24.3)	
Billy Robin Tom	Normal	199 (91.2)	3 (1.3)	202 (92.6)	0.264
	Increased	15 (6.9)	1 (0.4)	16 (7.3)	
Direct Bilirubin	Normal	207 (95)	3 (1.3)	210	0.140
	Increased	7 (3.2)	1 (0.4)	8	
Indirect bilirubin	Normal	206 (94.4)	4 (1.8)	210 (96.3)	>0.999
	Increased	8 (3.6)	0 (0)	8 (3.7)	



Table 2 presents the association between the ultrasound findings and clinical history of the patients.

### *Laboratory Findings*

The association between ultrasound findings and hematological tests and biochemical tests is shown in Tables 3 and 4.

Investigating the frequency of deep vein thrombosis in ultrasound examinations and its relationship with basic and clinical factors of patients' examination of ultrasound findings showed the presence of DVT in 4 patients (1.83%), while the ultrasound findings of 214 patients were normal. Among the blood markers mentioned in the laboratory findings section, D-dimer had an effect on the occurrence of deep vein thrombosis based on the research.

### **Discussion**

The focus of this study was centered on the utilization of an online perspective, which offers a multitude of advantages and implications for the investigation of DVT frequency among patients who were candidates for spinal surgery. By harnessing the capabilities of an online database housing patient records and medical histories, this study highlighted the wealth of readily accessible information that lends itself to comprehensive analysis. The adoption of this online perspective has numerous benefits, notably encompassing access to an extensive and comprehensive database, the ability to analyze a large sample size, efficiency in data collection, opportunities for multidimensional analysis, augmented generalizability, and seamless integration of technological advancements (7, 8). These advantages collectively contribute to more profound comprehension of DVT frequency among the spinal surgery candidates, resulting in the potential for enhanced preventive measures and increased patient care (9, 10).

Hospitalized spinal surgery candidates are particularly susceptible to DVT due to prolonged periods of immobility, consequently enhancing the risk of adverse complications and mortality. Quantifying the frequency of

this complication in this patient group holds a significant potential for guiding healthcare professionals in implementing effective prevention and management strategies. Since the occurrence rate of DVT in candidates for back surgery remains an uncharted territory, the fundamental objective of this study was to delve into the frequency of lower limb DVT among these patients (11).

The findings of this study indicated a DVT frequency of 1.83% among patients considered candidates for back surgery. Notably, there was no significant difference observed in terms of age distribution, height, weight, body mass index, employment status, history of hypertension, history of diabetes, history of blood loss, blood transfusion, or various blood markers between patients with and without DVT. It is imperative to acknowledge that while a correlation between elevated D-dimer levels and DVT presence was evident, the diagnostic potential of D-dimer tests should be interpreted with caution. False positives and negatives are possible due to such factors as test sensitivity, specificity, and patient-specific variations.

Incorporating ultrasound findings as a complementary diagnostic tool further solidifies the diagnosis of DVT. Non-invasiveness of ultrasonography, cost-effectiveness, and lack of known side effects make it a valuable technique for directly visualizing blood clots in the veins. The culmination of clinical evaluation, laboratory assessments, and imaging methods like ultrasound forms the basis for diagnosing DVT (12, 13).

To further underscore the relevance of the study findings, we present a comparative reference to previous research. The study by Liu and colleagues in 2016 found pre-operative DVT among surgical candidates with cervical spondylitis myelopathy (14). Their results highlighted the significance of such variables as D-dimer levels and ischemic cardiovascular history as predictors of DVT. While our study is in the same mine with some aspects of Liu's findings, variations may arise from differences in patients' demographics and lesion locations.

### Limitation and Suggestion

This study, however, had some limitations due to its retrospective nature, potentially introducing selection bias and interpretational discrepancies. Additionally, the relatively small sample size may limit the power of the study in full investigation of DVT frequency and its risk factors. As such, future prospective larger-scale studies are recommended to comprehensively delve into the intricacies of DVT occurrence and associated risk factors. It is suggested that innovative ways should be used to engage the patients remotely through digital platforms. Educative materials, interactive self-assessment tools, and remote consultations can empower the patients to actively participate in DVT prevention.

### Conclusion

In conclusion, the utilization of digital platforms in investigating the frequency of Deep Vein Thrombosis (DVT) among spinal surgery candidates brings a transformative dimension to medical research. The integration of online databases, real-time monitoring, machine learning, and personalized risk assessment offers a multifaceted approach to understanding the occurrence of DVT. By capitalizing on these digital advancements, we stand poised to enhance preoperative evaluations, preventive strategies, and patient care, ultimately forging a path toward safer and more informed spinal surgery interventions.

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### Authors' Contribution

All authors (MN, JR, AJ, AB, MM, SN, and HN) conceptualized the study, and all were major contributors to writing the manuscript. All authors approved the final manuscript.

### Ethical Consideration and Consent of Authors

This paper was approved by Iran University of Medical Sciences with the ethics code of

IR.IUMS.SMD.REC.1400.058. Also, all participants signed the research informed consent form before entering the study.

**Conflict of Interest:** None declared.

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