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The incidence and risk factors of thromboembolism in patients with traumatic spine fractures in a tertiary care hospital

Abdullah T. Eissa, MD.[1], Abdulaziz Alanagari[2], Fahed Alrowaili, MD.[3], Sami Aleissa, MD.[1]

[1]Department of Orthopedic Surgery, National Guard Health Affairs, [2]Medical student, College of Medicine, King Saud bin Abdulaziz University for Health Sciences, [3]Department of Rehabilitation, National Guard Health Affairs, Riyadh, Saudi Arabia.

***Corresponding author:**
Abdullah T. Eissa, MD., Department of Orthopedic Surgery, National Guard Health Affairs, Riyadh, Saudi Arabia.

eissaab@ngha.med.sa

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ABSTRACT

Objectives: Traumatic spine injuries may lead to devastating outcomes. One of the most common causes of death in these patients is thromboembolism, more with those who have risk factors. This study aimed to find out the incidence and associated risk factors of thromboembolism in traumatic spine fractures.

Methods: This retrospective cohort study included all adult patients with traumatic spine fractures from 2007 to 2014 in King Abdulaziz Medical City in Riyadh. Significant differences in the occurrence of deep vein thrombosis (DVT) or pulmonary embolism (PE) in traumatic spinal fractures were looked for.

Results: Out of 1128 patients with spine fractures, thromboembolism occurred in 73 (6.5%). In cervical spine fractures, DVT showed statistically significant association with the hospital length of stay, intensive care unit (ICU) length of stay, Glasgow Coma Scale (GCS), and motor vehicle accidents. On the other hand, PE was significantly associated with low GCS and longer ICU and hospital stays. In patients with lumbar fractures, DVT was highly correlated with longer hospital stay and ICU length of stay, low GCS, and severe injury severity score, while PE was highly correlated with high weight and longer hospital and ICU stay. Nevertheless, thoracic spine fractures victims have no significant association with any studied factors.

Conclusion: The incidence of thromboembolism was 6.5% in patients with spine fractures. A longer hospital and ICU stay were the main factors that were correlated with increased risk of thromboembolism in cervical and lumbar traumatic spine fractures. However, thoracic spine fractures had no association with any studied factors.

Keywords: Deep vein thrombosis, Pulmonary embolism, Risk factors, Spinal injury, Trauma, Thromboembolism, Vertebral fracture

INTRODUCTION

Spine injuries may lead to irreversible chronic defects and loss of neurological functions. These injuries may cause permanent damage and loss of motor and sensory functions below the insult level.[1] Patients with vertebral fractures, especially those who developed spinal cord injuries (SCI), have a higher tendency to have thrombosis. Thrombosis can be either deep vein thrombosis (DVT) or pulmonary embolism (PE). For that reason, as part of the medical practice,

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SCI patients should receive anticoagulant prophylaxis. Otherwise, 90% of those who do not receive any of these agents will develop thrombosis.[2] This event is considered the third most common cause of death in SCI patients. Patients with SCI have a higher risk of developing DVT (49–100%), especially in the first 2 weeks of the trauma.[3] In 50% of DVTs, it can lead to PE.[4]

Many risk factors were found to be associated with venous thromboembolism (VTE). For instance, older age is considered one of these factors.[5] Furthermore, paraplegic patients and those who have other comorbidities associated with SCI have a higher tendency to be affected by DVT or PE. In addition, gender and obesity were reported as risk factors.[6] In practice, many modalities are used as a prophylaxis for VTE in SCI patients, such as low-molecular-weight heparin, unfractionated heparin, and mechanical compression devices.[7]

The incidence of thromboembolism varies among all ethnicities. There are no exact definite figures in the west due to the differences in the diagnostic modalities. A study in the Swiss paraplegic center found that 6.6% of their patients had DVT, and it was complicated to PE in 1.45%.[8] However, it was reported that Asians have a significantly lower DVT incidence than Westerns.[9] In Saudi Arabia, the recorded data on thromboembolism in traumatic spine patients with or without SCI are limited and the registry still needs more time to find out an estimated incidence.[10]

Compared to the west, Saudi Arabia has very limited research conducted on thromboembolism cases. Therefore, it is essential to estimate this issue to have an idea about how thromboembolism in SCI affects Saudi hospitals in a matter of budgets, facilities, and medical staff. Thus, this study aimed to evaluate the incidence of thromboembolism and associated risk factors in traumatic spine fracture patients in King Abdullah Medical City (KAMC) in Riyadh from 2007 to 2014.

MATERIALS AND METHODS

It is a retrospective cohort study of all adult patients who were admitted and diagnosed with traumatic spinal fracture from 2007 to 2014 for the 1st month of admission in KAMC, a well-known Level 1 trauma center in Riyadh. While children (younger than 18), not traumatic, not diagnosed with SCI, or unavailable data were excluded from the study.

A data collection form was used to collect the patient's demographic characteristics such as age, gender, weight, as well as other clinical characteristics: The date of arrivals in the emergency department, intensive care unit (ICU) length stay, Glasgow Coma Scale (GCS), and patients' injury severity scores (ISS). The spinal fractures were identified based on a trauma CT scan report that was performed at the presentation. The neurological status of the patients, SCI or nerve root injury, and the presence or absence of DVT and PE were also recorded. Doppler ultrasound was utilized to diagnose DVT, and a chest CT angiogram was used for PE cases. The data were coded to maintain confidentiality, and it was kept safe.

The statistical analysis was done using Statistical Analysis System (SAS) software version 9.4 from SAS Institute (Cary, North Carolina, United States). The incidence of thromboembolism in traumatic spine injury was explored by calculating and plotting the rates within appropriate categories. Qualitative variables were presented as frequency (n) and percentages. Quantitative variables were given as mean ± standard deviation (STD). Chi-square was used to compare the qualitative variables. The student's t-test was applied to compare the quantitative variables to find out the significant differences in the occurrence of DVT or PE in SCI patients concerning age, gender, neurological deficit, level of injury, and cause of injury. $P < 0.05$ was considered significant for all the statistical analyses.

RESULTS

Out of 1128 patients diagnosed with traumatic spinal fractures, 467 (41.4%) had cervical spine fractures, 307 (27.2%) had thoracic spine fractures, and 354 (31.4%) of those patients had lumbar spine fractures. The mean age of injured patients was 34.4 years, and the vast majority of the cases affected were male (n = 971, 86.1%). Most of the traumatic spine fractures were caused by motor vehicle accidents (MVA), which were 889 cases (78.8%). Thromboembolism occurred in 73 patients (6.5%) out of all traumatic spine fractured patients.

Regarding the cervical spinal fracture [Table 1], the overall mean and STD for age was 36.4 ± 17.2, and the gender distribution between males and females was 406 (86.9%) and 61 (13.1%), respectively. Thus, VTE occurred in 35 (7.5%) cervical spine fractured patients out of 467 cases. DVT did not show any statistically significant association with age ($P = 0.249$) and did not show any difference in the association between genders significantly ($P = 0.74$). The weight variable had mean and STD as 74.5 ± 15.3, which is not associated significantly with developing DVT ($P = 0.594$). The neurological deficits did not show a statistically significant association with DVT ($P = 0.088$). The association between neurological deficit and DVT was statistically significant as $P = 0.013$. The mean and STD of the hospital and ICU length of stay were 1127.99 ± 59 and 19.37 ± 11.61, respectively. The hospital and ICU length of stay among those patients showed a statistically significant association with DVT, where their P-values were 0.0002 and 0.0008, respectively. The GCS score was classified as mild (13–15), moderate (9–12),

Table 1: Cervical spine injured patients who developed DVT and PE.

Variable	Demographic (*n*=461)	DVT (+ve)	*P*-value	PE (+ve)	*P*-value
		n=20		*n*=15	
Age (years)	36.32±17.05	38.65±14.47	0.249	5.67±14.39	0.248
Weight (Kg)	74.67±15.35	76.15±16.89	0.594	70.07±0.79	0.594
Hospital length of stay (days)	59.67±128.7	92.10±67.02	0	140.67±160.82	0.006
Critical care length of stay (days)	11.71±19.45	19.95±14.34	0	19.95±14.34	0.001
Gender					
Male	400 (86.77%)	17 (3.70%)	0.74	11 (2.42%)	0.129
Female	61 (13.23%)	3 (0.65%)		4 (0.88%)	
Glasgow Coma Scale					
Mild (13–15)	285 (61.82%)	6 (1.30%)		5 (1.10%)	0.003
Moderate (9–12)	32 (6.94%)	2 (0.43%)	0.006	2 (0.44%)	
Severe (3–8)	144 (31.24%)	12 (2.61%)		12 (2.64%)	
Injury severity score					
Major	244 (52.93%)	14 (3.04%)	0.102	14 (3.08%)	0.063
Minor	217 (47.07%)	6 (1.30%)		5 (1.10%)	
Mechanism of injury					
MVA	385 (83.51%)	17 (3.70%)	0.013	13 (2.86%)	0.61
Pedestrian	29 (6.29%)	2 (0.43%)		0	
Fall	21 (4.56%)	0		1 (0.22%)	
Motorcycle accident	16 (3.47%)	0		1 (0.22%)	
Homicide injury	1 (0.22%)	0		0	
Other accidents	9 (1.95%)	1 (0.22%)		0	
Neurological deficit					
No deficit	435 (94.57%)	17 (3.70%)	0.0875	14 (3.04%)	0.573
Neurological deficit	25 (5.42%)	3 (0.65%)		1 (0.22%)	
Type of injury					
Blunt	459 (99.57%)	20 (4.35%)	0.91	15 (3.26%)	1
Penetrating stab	1 (0.22%)	1 (0.22%)	1 (0.22%)	0 (0%)	
Penetrating gunshot	1 (0.21%)	1 (0.22%)	1 (0.22%)	0 (0%)	

MVA: Motor vehicle accident, DVT: Deep vein thrombosis, PE: Pulmonary embolism

and severe (<8), and their distributions were 291 (62.3%), 32 (6.9%), and 144 (30.8%), respectively. It had shown that there was a significant association between GSC score and DVT as $P = 0.0057$. The ISS code was categorized as major (16 or above) and minor (<16) and had a distribution as 244 (52.3%) and 223 (47.8%), respectively; it did not have any significant association with the DVT ($P = 0.1027$). The mechanisms of injury were categorized as MVA, which was the highest 389 (83.3%), followed by pedestrian 29 (6.2%), fall 21 (4.5%), motorcycle accident 17 (3.6%), homicide injury 1 (0.2%), and other accidents 10 (2.1%). They showed statistical significance concerning DVT ($P = 0.013$). The type of injury and DVT did not show any significant association. The pattern of fracture, which was classified as blunt, penetrating stab, and penetrating gunshot injuries, was distributed as 465 (99.6%), 1 (0.2%), and 1 (0.2%), respectively. Furthermore, there was a statistically significant association between PE and the hospital and ICU length of stay, and GCS score had shown as the p-values were 0.0034, 0.0059, and 0.0008, respectively [Table 1].

On the other hand, all the covariates, age, gender, hospital and ICU length of stay, GCS score, ISS, mechanism, and pattern of injuries, and neurological deficits did not show any association with the thoracic spine fractured patients who developed DVT [Table 2] or PE [Table 2] where $P < 0.05$ was considered. Out of 307 patients with thoracic spine injuries, 15 (4.9%) patients were diagnosed with thromboembolism.

Regarding the lumbar spine injured patients, 23 (6.5%) out of 354 cases had VTE. The age distribution, with mean and STD, was 32.8 ± 15.4 years, did not show any significant association with DVT ($P = 0.917$), and gender distribution, which was 301 (85.0%) males and 53 (14.97%) females, showed no association neither ($P = 0.23$). Similarly, the weight did not show any significant association ($P = 0.255$), and the distribution for weight was (mean and STD) 77.5 ± 18.8 kg. The overall hospital and ICU length of stay was a statistically significant association with developing DVT as *P*-values were 0.0052 and 0.0046, respectively. GCS and ISS code had shown a statistically significant association, and it shows that there was an association between GCS and DVT ($P = 0.0072$). Similarly,

Table 2: Thoracic spine injured patients who developed DVT and PE.

Variable	Demographic (*n*=307)	DVT (+ve)	*P*-value	PE (+ve)	*P*-value
		n=6		*n*=9	
Age	34.05±16.15	30.50±9.60	0.927	35.11±17.57	0.927
Weight	76.44±16.47	70.33±11.70	0.629	73.00±31.18	0.631
Hospital length of stay	59.07±123.59	69.83±66.42	0.12	93.78±97.35	0.098
Critical care length of stay	9.89±18.18	14.667±18.22	0.324	31.89±43.92	0.0744
Gender					
Male	264 (85.99%)	6 (1.97%)	0.6	8 (2.63%)	1
Female	43 (14.01%)	0		1 (0.33%)	
Glasgow Coma Scale					
Mild (13–15)	190 (61.89%)	3 (0.99%)	0.46	5 (1.64%)	0.728
Moderate (9–12)	21 (6.84%)	1 (0.33%)		0 (0%)	
Severe (3–8)	96 (31.27%)	2 (0.66%)		4 (1.32%)	
Injury severity score					
Major	181 (58.96%)	176 (57.89%)	1	7 (2.30%)	0.319
Minor	126 (41.04%)	122 (40.13%)		2 (0.66%)	
Mechanism of injury					
MVA	239 (77.85%)	6 (1.97%)	1	8 (2.63%)	0.9
Pedestrian	25 (8.14%)	0		1 (0.33%)	
Fall	20 (6.51%)	0		0	
Motorcycle accident	12 (3.91%)	0		0	
Homicide injury	4 (1.30%)	0		0	
Other accidents	6 (1.95%)	0		0	
No deficit	259 (85.20%)	4 (1.32%)	0.218	8 (2.63%)	1
Neurological deficit	45 (14.66%)	2 (0.66%)		1 (0.33%)	
Type of injury					
Blunt	303 (98.70%)	6 (1.97%)	1	9 (2.96%)	1
Penetrating stab	0	0		0	
Penetrating gunshot	4 (1.30%)	0		0	

MVA: Motor vehicle accident, DVT: Deep vein thrombosis, PE: Pulmonary embolism

ISS had $P = 0.0189$. The other variables, such as the mechanism of injury, neurological deficit, type of injury, and safety, did not show any statistically significant association as *P*-values were greater than 0.05. Furthermore, the patients' weight, hospital, and ICU length of stay were statistically significantly associated with developing PE as *P*-values were 0.0364, 0.0052, and 0.0046, respectively. However, the gender, GCS, ISS, mechanism of injury, neurological deficit, safety, and type of injuries were statistically insignificant since p-values were greater than 0.05, which show that they did not have any association with the PE in lumbar spine fractured patients [Table 3].

DISCUSSION

The consequences of traumatic spine fractures, including cord injury, are devastating; VTE is one of the major causes of death in these patients.[11] For that reason, recognizing and predicting all factors that can lead to unwanted events of spine fractures are crucial.

This study found that 73 patients (6.5%) out of all 1128 traumatic spine fracture patients in KAMC-Riyadh were diagnosed with thromboembolism. This rate is higher than previously published studies. Samuel *et al.* found that 2.5% of over 190,000 data-based patients had VTE.[12] Kim *et al.* reported that 2.1% out of 48 registered patients had thromboembolism.[13] Moreover, the present study detected that the cervical spine fracture patients had the highest rate of VTE with 7.5%, the lumbar fracture patients had 6.5%, and the thoracic fracture patients had the lowest rate of VTE with 4.9%. However, these outcomes contradict what was found in Samuel *et al.*'s study, which found that the patients with traumatic thoracic spine injuries had the highest tendency to develop thromboembolism with 3.1% followed by the lower cervical patients with 3%.[12] All the mentioned studies agree with the rate published in recent studies and meta-analyses, ranging between 1 and 12%.[14]

This study found some factors that may increase the risk of thromboembolism in traumatic spine fracture patients despite giving prophylactic anticoagulation. Preventing these factors may decrease the morbidity and mortality rate associated with these injuries. The analysis found that traumatic cervical spine fracture patients had the highest tendency to develop DVT with longer hospital and ICU stay,

Table 3: Lumbar spine injured patients who developed DVT and PE.

Variable	Demographic (n=354)	DVT (+ve)	*P*-value	PE (+ve)	*P*-value
		n=12		*n*=11	
Age	32.82±15.40	32±13.96	0.917	28.81±11.10	0.501
Weight	77.50±18.76	87.33±26.72	0.255	86.91±14.50	0.036
Hospital length of stay	41.06±70.77	74.58	0.005	70.73±47.64	0.005
Critical care length of stay	7.27±13.24	15.00±11.70	0.005	13.273±13.97	0.005
Gender					
Male	301 (85.03%)	12 (3.42%)	0.23	7 (2.00%)	0.07
Female	53 (14.97%)	0		4 (1.14%)	
Glasgow Coma Scale					
Mild (13–15)	230 (64.97%)	225 (64.10%)	0.007	5 (1.43%)	0.141
Moderate (9–12)	30 (8.47%)	28 (7.98%)		0 (0%)	
Severe (3–8)	94 (26.55%)	86 (24.50%)		6 (1.71%)	
Injury severity score					
Major	187 (52.82%)	11 (3.13%)	0.019	7 (2.00%)	0.568
Minor	166 (46.89%)	1 (0.28%)		4 (1.11%)	
Mechanism of injury					
MVA	261 (73.73%)	10 (2.85%)	1	10 (2.86%)	0.66
Pedestrian	30 (8.47%)	1 (0.28%)		1 (0.29%)	
Fall	49 (13.84%)	1 (0.28%)		0	
Motorcycle accident	4 (1.13%)	0		0	
Homicide injury	1 (0.28%)	0		0	
Other accidents	6 (1.69%)	0		0	
Neurological deficit					
No deficit	348 (98.31%)	11 (3.13%)	0.19	10 (2.86%)	0.18
Neurological deficit	6 (1.69%)	1 (0.28%)		1 (0.29%)	
Type of injury					
Blunt	353 (99.72%)	12 (3.42%)	1	11 (3.14%)	1
Penetrating stab	0	0		0	
Penetrating gunshot	1 (0.28%)	0		0	

MVA: Motor vehicle accident, DVT: Deep vein thrombosis, PE: Pulmonary embolism

low GCS at presentation, and post-MVA. Moreover, those traumatic cervical spine fracture patients with longer hospital and ICU stay, and low GCS had a higher association with PE. Furthermore, longer hospital and ICU stay, low GCS, and severe ISS scores showed a significant relation with DVT in traumatic lumbar spine fracture patients. Furthermore, high weight and longer hospital and ICU stay were significantly associated with PE. On the contrary, none of these factors had any significant relation with thoracic spine fractures.

Age and gender in our study were not correlated significantly with VTE in all fracture spine levels. However, in other studies, both factors were linked to VTE with significant *P*-values.[15-17] In addition, neurological deficits are not significantly associated with DVT or PE in all spine segments fracture. This finding controverts with most studies that presented a significant association between neurological injuries of the spine and developing VTE in spinal patients.[18,19]

On the other hand, some of these factors were found to be associated with VTE in other studies as well, for instance, a longer duration of the hospital[20] and ICU[21] stay. Both circumstances led to decreased physical activity, which will increase the risk of developing thrombosis by affecting Virchow's triad.[22] Furthermore, although all these admitted traumatic spine fracture patients had prophylactic anticoagulation, some patients had a thromboembolism event in the 1st month of admission. For that reason, further studies are warranted to figure out if some traumatic spinal fracture patients may need an aggressive or therapeutic dose of anticoagulation to prevent VTE or to establish new criteria for the mentioned patients.

There are some limitations to this study. It was conducted in a single trauma center. The type of fracture was not identified and lacked a detailed description of the anticoagulation prophylaxis.

CONCLUSION

This study revealed that VTE incidence in traumatic spine fracture patients is 6.5%, which is higher than previously published studies. Length of hospital and ICU stay are the

major factors that may increase the risk of thromboembolism in cervical and lumbar traumatic spine fracture patients. Patients with low GCS have a higher tendency to develop DVT and PE in cervical fracture patients and DVT in lumbar fracture patients. In addition, MVA victims have a higher association with DVT in cervical fractures, and a high ISS score is highly correlated with DVT in lumbar fracture patients. High weight was only a risk factor for PE in lumbar fracture patients. Contrarily, none of the mentioned factors are significantly associated with traumatic thoracic spine fracture patients.

RECOMMENDATIONS

This study strongly recommends that the criteria of thromboembolism prophylaxis in traumatic spine fractures need to be revised, such as patients with low GCS and who is expected to have a longer duration of stay in the hospital. In addition, further clinical studies are warranted to find out the appropriate dosing of anticoagulation in traumatic spine fractured patients.

AUTHORS' CONTRIBUTIONS

ATE conceived and designed the study, conducted research, analyzed and interpreted, and wrote the initial and final draft of the article. AA provided research materials and collected and organized data. FA and SA provided logistic support. All authors have critically reviewed and approved the final draft and are responsible for the manuscript's content and similarity index.

ETHICAL APPROVAL

Study Number: RC18/362/R, with an IRB approval date: October 30, 2019.

Declaration of patients 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 conflicts of interest to disclose.

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