Original Article
Incidence and risk factors of early deep venous thrombosis after posterior cervical surgery-382 cases report

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Abstract: Background: The purpose of this retrospective study was to investigate the prevalence of DVT and identified associated risk factors for DVT in patients admitted to hospital for posterior cervical surgery. Method: In this comparative study, 382 patients admitted for posterior cervical surgery who was allocated to two groups, those who developed DVT (DVT group) postoperatively and those who did not (non-DVT group). To examine the perioperative risk factors for DVT after posterior cervical surgery, comparative analysis of the two groups was done. Result: DVT was detected in 7.1% (27/382) patients, including 1 proximal DVT patients (3.7%) and 26 distal DVT patients (96.3%). According to multivariate logistic regression analysis, the age (P = 0.015, OR 1.026, 95% CI: 0.9631-1.1536), history of hyperlipidemia and major surgery (P = 0.015, OR 6.221, 95% CI: 1.1243-3.3297; P = 0.013, OR 1.642, 95% CI: 1.0954-2.1510) and D-dimer (P = 0.003, OR 1.542, 95% CI: 1.0236-2.2631) were significant risk factors relative to the onset of DVT after posterior cervical surgery. Conclusion: The incidence of DVT in patients who undergo posterior cervical surgery was 7.1% (27/382). Patients admitted to hospital for posterior cervical surgery with increased age, D-dimer, history of hyperlipidemia and major surgery might be at increased risk for postoperative DVT.

Keywords: Deep venous thrombosis, posterior cervical surgery, risk factors

Introduction

Venous thromboembolism (VTE), including deep vein thrombosis (DVT) and pulmonary embolism (PE), was a common complication associated with fatality and life threatening events after surgery [1-3]. To avoid the development of DVT, it was essential to screen for perioperative DVT and reduce the onset of DVT. On account of the clinical features and symptoms of DVT after surgery were mainly non-specific and non-sensitive. To determine the frequency of DVT after orthopedic surgery by using Doppler ultrasonography (US), which was regarded as the standard method because of less invasiveness and higher sensitivity.

Previous studies mainly focused on total knee or hip arthroplasty, trauma and spinal cord injury [4-6]. However, it was difficult to generalize about the incidence of DVT after spinal surgery compared with other surgeries. There was lacking in information on the prevalence of DVT following elective spine surgery, especially for the cervical degenerative disease treated with posterior surgeries. There were many risk factors for DVT following elective spine surgery such as advanced age, female gender, spinal level, neurologic deficits and spinal tumors [7-9].

The exact incidence of DVT after posterior cervical surgery which generally involved many surgical procedures for variety of pathologies had not been clarified. Although cervical spine surgery carried a low risk of critical DVT compared with other surgeries, the need for assessment of DVT development was also important. To our knowledge, no study has been published evaluating time to a DVT event after posterior cervical surgery. Thus, the purpose of this retrospective study was to investigate the prevalence of DVT and identified associated risk factors for DVT in patients admitted to hospital for posterior cervical surgery.

Materials and methods

From January of 2005 to December of 2014, 382 patients admitted for posterior surgery for the multilevel cervical spondylotic myelopathy (CSM) at the Third Hospital of Hebei Medical University. Surgical techniques for the multilevel CSM were mainly decided based on severity of ossification of the cervical posterior longitudinal ligament (OPLL), sagittal alignment of the cervical spine and surgeons' experience. There were 3 popular methods of posterior surgeries included laminoplasty, laminectomy alone and laminectomy and fusion for the treatment of cervical degenerative disease. The patients' age, gender, body mass index (BMI) and data from the medical history and medical condition were recorded. Patients with oral anticoagulant therapy 1 week prior to the surgery were excluded in this study. Those patients with a previous history of DVT or the existence of DVT was detected preoperatively were also excluded from this study. The study was approved by Ethics Committee of The Third Hospital of HeBei Medical University.

Doppler US was performed on all patients from the bilateral femoral to lower limb to detect the existence of DVT as a preoperative and postoperative examination. The criteria for the diagnosis of DVT were the following: loss of compressibility of the vein; presence of intraluminal echogenicity; and absence of venous flow determined using sonographic scanner with a linear transducer.

According to the findings of postoperative examination, patients were divided into DVT group and non-DVT group. Risk factors, which used for this study, were age, gender, BMI, smoking, posterior surgery technique, intraoperative cerebrospinal fluid (CSF) leakage, history of hypertension, hyperlipidemia, diabetes mellitus, major surgery (any surgical procedure that involves anesthesia or respiratory assistance) and laboratory blood test (serum D-dimer, prothrombin time-international normalized ratio (PT-INR), activated partial thromboplastin time (APTT), and prothrombin tine (PT).

Statistical analysis

Statistical analysis was performed with SPSS 17.0 for Windows (SPSS Inc., Chicago, IL, USA).

The patients' characteristics were compared between the DVT and non-DVT patients using the Mann-Whitney U test and Fisher's exact test. After these univariate analyses, a P < 0.2 was selected and evaluated by multivariate logistic regression analysis. Conclusively, a P < 0.05 was considered statistically significant.

Results

Patient characteristics

The patient characteristics were summarized in **Table 1**. A total of 382 patients (237 men and 145 women) with age of 61.3±10.9 years old (range from 35-80 years old) were enrolled in this study. All patients completed the study without any life-threatening complications. In DVT group, the most frequent medical history or medical condition was hypertension (200 patients, 52.4%) and hyperlipidemia (188 patients, 49.2%). The second was major surgery (171 patients, 44.8%) which included a history of anterior cervical surgery and abdominal surgery.

Incidence of postoperative DVT

The overall incidence of DVT was 7.1% (27/382) and no patient had symptomatic DVT. Of 27 DVT-positive patients, the distal thrombus was identified in 26 (96.3%); the proximal thrombus was only identified in 1 (3.7%). The mean age in DVT group was significantly older than that of DVT-negative patients (P = 0.005). Hyperlipidemia was seen in 47.3% (168/355) of the DVT-negative group and 74.1% (20/27) of the DVT-positive group (P = 0.007). There were 70.4% (19/27 patients) of the DVT-positive group had undergone major surgery, but only 42.8% (152/355) of the DVT negative group had undergone major surgery (P = 0.006). Hypertension was seen in 51.3% (182/355) of the DVT-negative group and 66.7% (18/27) of the DVT-positive group (P = 0.041). The mean duration of postoperative bed rest in DVT group was slightly longer than that of DVT-negative patients, but the difference was not significant (P = 0.112) (**Table 1**).

Multivariate analysis of the risk factors for DVT

In univariate analysis, differences were found between the DVT group and non-DVT group regarding age, gender, history of hyperlipid-

Table1. Univariate analysis of the risk factors for DVT

Characteristic	DVT group	Non-DVT group	P value
No. of patients	27	355	
Age	63.8±12.3	56.1±11.9	0.005
Gender (M/F)	20/7	217/138	0.181
BMI (kg/m^2)	24.6±3.8	23.3±2.5	0.376
Smoking	16/11	218/137	0.852
Hypertension	18	182	0.122
Hyperlipidemia	20	168	0.007
Diabetes mellitus	15	161	0.927
Major surgery	19	152	0.006
Surgical technique			0.983
Laminoplasty	13	165	
Laminectomy alone	3	39	
Laminectomy and fusion	11	151	
Operative time	156. 8±39.5	134. 6±32.8	0.094
CSF leakage	19	92	0.000
Duration of postoperative bed rest	4.2±1.3	5.6±1.8	0.112
Laboratory blood test			
D-dimer mg/L	1.62±0.32	0.25±0.09	0.001
PT-INR	0.98±0.21	0.99±0.16	0.227
APTT s	30.53 ±9.91	29.42 ±9.08	0.628
PT s	13.12 ±5.12	12.82 ±5.02	0.802

Table 2. Multivariate analysis of the risk factors for DVT

Risk factor	P	OR	95% CI
Age	0.015	1.026	0.9631-1.1536
Gender	0.318	1.149	1.1252-2.2331
Hypertension	0.276	0.232	0.9853-0.9368
Hyperlipidemia	0.015	6.221	1.1243-3.3297
Major surgery	0.013	1.642	1.0954-2.1510
CSF leakage	0.031	0.253	0.1536-0.8393
Operative time	0.065	2.175	0.9621-1.3113
D-dimer	0.003	1.542	1.0236-2.2631

emia, hypertension and major surgery, operative time, CSF leakage and D-dimer (P < 0.2). Multivariate logistic regression analysis was performed for these 8 factors. According to multivariate logistic regression analysis, the age (P = 0.015, OR 1.026, 95% CI: 0.9631-1.1536), history of hyperlipidemia and major surgery (P = 0.015, OR 6.221, 95% CI: 1.1243-3.3297; P = 0.013, OR 1.642, 95% CI: 1.0954-2.1510) and D-dimer (P = 0.003, OR 1.542, 95% CI: 1.0236-2.2631) were significant risk factors relative to the onset of DVT after poste-

rior cervical surgery (**Table 2**).

Discussion

The main findings of this study were as follows: DVT was detected in 27 patients (7.1%), including 26 distal DVT patients (96.3%) and 1 proximal DVT patients (3.7%). The age, D-dimer value, history of hyperlipidemia and major surgery were positively correlated with the onset of DVT after posterior cervical surgery.

DVT was one of the most common and dangerous complications of spinal surgery, as it could result in a fatal PE. Asymptomatic DVT had been shown to increase rates of fatal PE in patients undergoing total joint arthroplasty in their lower extremities. Previous studies had reported the prevalence of and risk factors for VTE after spinal surgery. However, it has not been specific clarified, especially on posterior cervical surgery. Several studies had indicated the low incidence of VTE at the cervical spine compared other spinal levels. The prevalence of deep venous thrombosis was statistically significant in cervical compared with lumbar procedures. Yoshioka et al. had found the rate of VTE varies accompany with the different spinal levels. The rate of VTE after cervical spinal surgery was 3.0% (5/167 cases), which is significantly low in the multivariate analysis. In their study, it had demonstrated cervical spine surgery had a low risk of DVT compared with other surgeries which could be attributed to the cervical spinal levels owing to the upper extremities had a low risk compared with the lower extremities [10]. Weber et al. analyzed 107 consecutive patients undergoing elective lumbar spinal fusion who were evaluated for VTE by lower limb Doppler US and clinical observation. They found the actual incidence of VTE in these patients was low [11]. In a prospective clinical study, Oda et al. found 17 patients (15.5%) after posterior spinal surgery showed evidence of DVT by venography. There

were 3 of 54 patients with cervical laminoplasty showed venographic evidence of DVT. The average age of the patients without VTE was 58, which was significantly lower comparing with the patients who sustained a VTE. No statistically significant difference was noted for thoracic spine surgery compared with cervical or lumbar surgery. Dearborn et al. studied 116 spinal surgery patients who were examined with duplex ultrasound to determine the incidence of DVT. In their study, 6 of the symptomatic PE occurred after combined anterior/posterior spinal fusions (6%), whereas only one occurred after posterior decompression and fusion (0.5%) [13].

Currently, the North American Spine Society (NASS) does not have definitive guidelines for administering chemoprophylaxis, but does state that chemoprophylaxis may not be warranted in elective spine surgery in patients with a low thromboembolic risk-profile. There was Level IV evidence that LMWH can be started safely on the day of elective spine surgery. It had recommended that LMWH be used cautiously before routine, elective spinal surgery and withheld unless there are other risk factors for thromboembolism [14]. Strom et al. had retrospectively reviewed for all cases of cervical laminectomy to assess the safety and efficacy of prophylactic low molecular-weight heparin (LMWH) started 24 to 36 hours after degenerative spine surgery. Starting on postoperative day 1, patients were routinely administered daily prophylactic enoxaparin at 10 pm (40 mg for normal renal function, 30 mg for creatinine clearance of < 30 mL/min). In their studies, LMWH prophylaxis seems to carry a very low hemorrhage risk when started 24 to 36 hours after spine surgery. Even with aggressive prophylaxis, patients undergoing fusion or multi-level laminectomy for degenerative disease are at significant risk for VTE [15]. In this series, there were no patients with clinical signs of DVT and PE. The overall incidence of DVT was 7.1% (27/382) and no patient had symptomatic DVT. Of 27 DVT-positive patients, the distal thrombus was identified in 26 (96.3%); the proximal thrombus only was identified in 1 (3.7%). The mean age in DVT group was significantly older than that of DVT-negative patients (P = 0.015).

Although statistical support for spine-specific risk factors was lacking, several studies had noted common observations for patients who sustained a DVT. Risk assessment had been developed to allow a more accurate stratification of patients according to their overall DVT risk. Previous studies had demonstrated many factors contribute to VTE after spinal surgery which included advanced age, major trauma, hypertension, spinal cord injury, diabetes, previous history of VTE. Yoshioka et al. demonstrated the statistically significant risk factors for DVT included advanced age, neurologic deficits and spinal tumor. Spinal tumor was a high risk of DVT, whereas cervical spine surgery carries a low risk. They also found the fibrin monomer complex measured 1 day after spine surgery was considered to be useful as an indicator of DVT [10, 16]. In addition to the risk factors discussed above, Geerts et al. added decreased postoperative mobility, increased surgical time and history of venous thrombosis as risk factors [17]. Maung et al. reported the rate of DVT differs with various spinal cord injury levels. Patients with cervical injury at one of the lowest risk compared to thoracic injury. Their study demonstrated that level of spinal cord injury level was an independent risk factor for DVT with the highest rate in patients with a T1-6 level [18]. Oda et al. found a statistically significant risk of VTE associated with advanced age and anatomic location of surgery. Whereas there was no statistically increased risk associated with gender, operating time, intraoperative blood loss, postoperative bed rest or interval from surgery to venography [12].

Statistical support for cervical spine specific risk factors was lacking, so it was important to identify the risk factors for DVT associated with posterior cervical surgery. However, there was a problem due to lack of specifics in the literature concerning the patients with posterior cervical surgery. In the present cohort, looking at the patients' medical histories, there was much higher prevalence of postoperative DVT in hyperlipidemia. The prevalence of postoperative DVT was significantly higher in patients with Intraoperative CSF leak for primary posterior cervical surgery than others. Therefore, intraoperative CSF leak might induced much long operative time and prolonged bed rest, which might have an increased risk of developing VTE. In the present study, the results indicated that more patients with a history of major surgery in DVT group than non-DVT group.

However, there was no significant difference among the 3 posterior cervical surgery techniques. Therefore, it believed that the surgical technique itself didn't have a higher impact on the incidence of VTE. Univariate analysis found that age, gender, history of hyperlipidemia, hypertension and major surgery, operative time, CSF leakage and D-dimer tended to be risk factors for DVT. According to the multivariate logistic regression analysis, it had shown that age, D-dimer, history of hyperlipidemia and major surgery were independent risk factors for postoperative DVT in patients admitted for posterior cervical surgery.

Reducing the risk of VTE in patients undergoing posterior cervical surgery, it had recommended mechanical prophylaxis with graduated compression stockings, intermittent pneumatic compression or foot impulse devices as lone thromboprophylactic measures for low-risk patients [19]. Sansone et al. had indicated the risk of DVT and PE was relatively low following elective spine surgery, particularly for patients who receive pharmacologic prophylaxis. Unfortunately, pharmacologic prophylaxis exposes patients to a greater risk of epidural hematoma [20]. In our opinion, for patients with one or more related risk factors, mechanical prophylaxis and low molecular weight heparin was advised.

However, there were several limitations in this study. Firstly, it needed more patients included, which would have been possible to analyze the effects of various events in the medical history and more risk factors for VTE. Secondly, there was only one method of diagnosing DVT. The diagnosis of asymptomatic DVT was based on Doppler US. Furthermore, more evidence was needed prior to establishing a protocol for prophylaxis against DVT in patients undergoing posterior cervical surgery. Future prospective studies should seek to define the safety of various prophylactic modalities and to identify specific subpopulations of patients who were at greater risk for DVT.

Conclusion

In conclusion, the incidence of DVT in patients who undergo posterior cervical surgery was 7.1% (27/382). Patients admitted to hospital for posterior cervical surgery with increased age, D-dimer, history of hyperlipidemia and

major surgery might be at increased risk for postoperative DVT. Surgeons should be pay attention to decrease the incidence of DVT if specific risk factors were present.

Disclosure of conflict of interest

None.

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References

[1] Heck CA, Brown CR, Richardson WJ. Venous thromboembolism in spine surgery. J Am Acad Orthop Surg 2008; 16: 656-64.

[2] Jiang J, Teng Y, Fan Z, Khan S, Xia Y. Does obesity affect the surgical outcome and complication rates of spinal surgery? A meta-analysis. Clin Orthop Relat Res 2014; 472: 968-75.

[3] Tominaga H, Setoguchi T, Tanabe F, Kawamura I, Tsuneyoshi Y, Kawabata N, Nagano S, Abematsu M, Yamamoto T, Yone K, Komiya S. Risk factors for venous thromboembolism after spine surgery. Medicine (Baltimore) 2015; 94: e466.

[4] Shimoyama Y, Sawai T, Tatsumi S, Nakahira J, Oka M, Nakajima M, Jotoku T, Minami T. Perioperative risk factors for deep vein thrombosis after total hip arthroplasty or total knee arthroplasty. J Clin Anesth 2012; 24: 531-6.

[5] Giorgi Pierfranceschi M, Donadini MP, Dentali F, Ageno W, Marazzi M, Bocchi R, Imberti D. The short- and long-term risk of venous thromboembolism in patients with acute spinal cord injury: a prospective cohort study. Thromb Haemost 2013; 109: 34-8.

[6] Chung WS, Lin CL, Chang SN, Chung HA, Sung FC, Kao CH. Increased risk of deep vein thrombosis and pulmonary thromboembolism in patients with spinal cord injury: a nationwide cohort prospective study. Thromb Res 2014; 133: 579-84.

[7] Akeda K, Matsunaga H, Imanishi T, Hasegawa M, Sakakibara T, Kasai Y, Sudo A. Prevalence and countermeasures for venous thromboembolic diseases associated with spinal surgery: a follow-up study of an institutional protocol in 209 patients. Spine (Phila Pa 1976) 2014; 39: 791-7.

[8]   Takahashi H, Yokoyama Y, Iida Y, Terashima F, Hasegawa K, Saito T, Suguro T, Wada A. Incidence of venous thromboembolism after spine surgery. J Orthop Sci 2012; 17: 114-7.

[9]   Cunningham JE, Swamy G, Thomas KC. Does preoperative DVT chemoprophylaxis in spinal surgery affect the incidence of thromboembolic complications and spinal epidural hematomas? J Spinal Disord Tech 2011; 24: E31-4.

[10] Yoshioka K, Murakami H, Demura S, Kato S, Hayashi H, Inoue K, Ota T, Shinmura K, Yokogawa N, Fang X, Tsuchiya H. Comparative study of the prevalence of venous thromboembolism after elective spinal surgery. Orthopedics 2013; 36: e223-8.

[11] Weber B, Seal A, McGirr J, Fielding K. Case series of elective instrumented posterior lumbar spinal fusions demonstrating a low incidence of venous thromboembolism. ANZ J Surg 2014; [Epub ahead of print].

[12] Oda T, Fuji T, Kato Y, Fujita S, Kanemitsu N. Deep venous thrombosis after posterior spinal surgery. Spine (Phila Pa 1976) 2000; 25: 2962-2967.

[13] Dearborn JT, Hu SS, Tribus CB, Bradford DS. Thromboembolic complications after major thoracolumbar spine surgery. Spine (Phila Pa 1976) 1999; 24: 1471-6.

[14] Bono CM, Watters WC 3rd, Heggeness MH, Resnick DK, Shaffer WO, Baisden J, Ben-Galim P, Easa JE, Fernand R, Lamer T, Matz PG, Mendel RC, Patel RK, Reitman CA, Toton JF. An evidence-based clinical guideline for the use of antithrombotic therapies in spine surgery. Spine J 2009; 9: 1046-51

[15] Strom RG, Frempong-Boadu AK. Low-molecular-weight heparin prophylaxis 24 to 36 hours after degenerative spine surgery: risk of hemorrhage and venous thromboembolism. Spine (Phila Pa 1976) 2013; 38: E1498-502.

[16] Yoshioka K, Kitajima I, Kabata T, Tani M, Kawahara N, Murakami H, Demura S, Tsubokawa T, Tomita K. Venous thromboembolism after spine surgery: changes of the fibrin monomer complex and D-dimer level during the perioperative period. J Neurosurg Spine 2010; 13: 594-9.

[17] Geerts WH, Pineo GF, Heit JA, Bergqvist D, Lassen MR, Colwell CW, Ray JG. Prevention of venous thromboembolism: the Seventh ACCP Conference on Antithrombotic and Thrombolytic Therapy. Chest 2004; 126 Suppl: 338S-400S.

[18] Maung AA, Schuster KM, Kaplan LJ, Maerz LL, Davis KA. Risk of venous thromboembolism after spinal cord injury: not all levels are the same. J Trauma 2011; 71: 1241-5.

[19] Bryson DJ, Uzoigwe CE, Braybrooke J. Thromboprophylaxis in spinal surgery: a survey. J Orthop Surg Res 2012; 7: 14.

[20] Sansone JM, del Rio AM, Anderson PA. The prevalence of and specific risk factors for venous thromboembolic disease following elective spine surgery. J Bone Joint Surg Am 2010; 92: 304-13.