

Thromboembolic complications after spinal surgery in trauma patients

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Background Deep venous thrombosis (DVT) and pulmonary embolism (PE) may be significant complications following spinal surgery. The incidence rate ranges from 0.5% to 2.5% in patients with symptomatic thromboembolic disease and up to 15% in patients with non-symptomatic thrombotic complications. We determined the incidence of symptomatic thromboembolism after spinal surgery in patients with postoperative systemic prophylaxis and investigated general and specific risk factors for development of this disease.

Patients and methods We analyzed the clinical records of 978 patients who had undergone surgery of the spine because of trauma and who had been admitted to our level-I trauma center between 1980 and 2004. Spinal procedures included anterior and/or posterior spinal fusion, video-assisted thoracoscopic fusion, and spinal decompression. Symptomatic thromboembolic disease was diagnosed when patients showed significant clinical signs or symptoms of DVT or PE. In cases of DVT, diagnosis was confirmed by duplex scan of the lower limbs; in cases of PE, diagnosis was confirmed by CT-scanning of the thorax or at post mortem.

Results The incidence rate of symptomatic thromboembolic complications was 2.2% (n 22). 17 patients showed clinical signs of deep venous thrombosis, with 4 of them developing pulmonary embolism subsequently. The other 5 patients developed pulmonary embolism without prior clinical signs of deep venous thrombosis. 6 patients died because of thromboembolic disease. Thromboembolic complications were more frequent in older patients and among males, as well as in patients with regular tobacco consumption and obesity. Thromboembolic complications were also seen more frequently

in patients with surgical procedures at the lumbar spine, in patients with anterior spinal fusion, and in those with motor deficits in the lower extremities.

Interpretation We found a rather low rate of clinically significant thromboembolic complications after spinal surgery because of trauma, compared to the results reported in the literature. Level of spinal surgery, surgical approach, and motor deficits in the lower extremities were identified as specific risk factors for DVT or PE. Age, sex, obesity and regular smoking were identified as general risk factors. ■

While thromboembolic disease has been studied extensively in patients who have undergone hip or knee surgery, it has received less attention in patients who have undergone spinal surgery (Ferree and Wright 1993, Rokito et al. 1996, Lee et al. 2000, Oda et al. 2000, Anderson et al. 2003). A review of the literature shows that deep venous thrombosis (DVT) and pulmonary embolism (PE) may be significant complications following spinal surgery. The incidence rates are 0.5–2.5% in patients with symptomatic thromboembolic disease and up to 15% in patients with non-symptomatic thrombotic complications (proven by venography or sonography) (Lea et al. 1978, West and Anderson 1992, Ferree et al. 1993, Smith et al. 1994, Rokito et al. 1996, Dearborn et al. 1999).

Prophylactic measures—both mechanical and systemic—are commonly used to lower the incidence rates. It has also been noted previously that

patients undergoing spinal surgery have a number of specific risk factors for development of deep venous thrombosis, such as length of operative procedure, prolonged postoperative recumbency, prone positioning, manipulation of the great vessels during operation, and motor paralysis in the lower extremities (Ferree and Wright 1993, Ferree et al. 1993, Smith et al. 1994, Rokito et al. 1996, Lee et al. 2000, Oda et al. 2000).

We determined the incidence of symptomatic thromboembolism after spinal surgery in trauma patients with postoperative systemic prophylaxis and investigated general and specific risk factors for development of this disease.

Patients and methods

We reviewed admission data at the trauma registry of Vienna General Hospital, University of Vienna Medical School, and identified all trauma patients with significant skeletal and/or non-skeletal injuries of the spine who had been admitted to this level-I trauma center between 1980 and 2004. The trauma registry of Vienna General Hospital is a prospectively gathered database; it was established for registration of injury characteristics (type, mechanism, etc.) and demographic data of trauma patients.

Patients who underwent major spinal surgery because of spinal trauma were identified and their dataset was examined for completeness and accuracy. According to our inclusion criteria, only patients with complete sets of data were included in the study.

From the database of 3,262 patients with significant skeletal or non-skeletal injuries of the spine, the clinical records revealed that 2,256 (69%) were treated nonoperatively, whereas 1,006 patients (31%) underwent major spinal surgery during the 25-year period. 28 of the latter (3%) were excluded from the study, either because their sets of data were found to be incomplete (n 11) or because they had undergone spinal surgery due to non-traumatic pathologies (n 17).

Symptomatic thromboembolic disease was diagnosed when patients showed significant clinical signs or symptoms of DVT (such as increasing edema of the lower extremity, calf tenderness, pos-

Table 1. Level of injury (n=978)

Level of injury	n
Cervical spine	378
Thoracic spine	258
Lumbar spine	324
More levels	18

Table 2. Surgical procedure (n=978)

Surgical procedure	n
Anterior spinal fusion	263
Posterior spinal fusion	290
Anterior and posterior fusion	138
Video-assisted thoracoscopic fusion	27
Spinal decompression	21
Decompression and fusion	239

itive Homan's sign) or of PE (respiratory distress, respiratory insufficiency, signs of upper inflow congestion). In cases of DVT, D-dimer profile and duplex scan of the lower limbs were performed to confirm the diagnosis. In cases of PE, patients underwent CT-scanning of the thorax or PE was diagnosed at postmortem.

For statistical analysis, clinical and demographic data of trauma patients with thromboembolic complications were compared to those of patients without thromboembolic disease using logistic regression analysis, to identify potential general or specific risk factors. The criteria we analyzed included age, sex, level of injury, type of operative procedure, surgical approach, operation time, and length of postoperative recumbency.

Results

978 patients (626 men) with an average age of 40 (2–78) years met our criteria for inclusion: 727 patients underwent spinal surgery due to fractures (n 727), 205 due to fractures with dislocation, and 46 because of discoligamentary instabilities. 466 patients had an isolated injury of the spine, whereas 512 patients showed concomitant injuries during primary trauma evaluation (Tables 1 and 2).

561 patients (57%) underwent only one operative procedure, while the remainder had more than one operation. The average length of operative procedures was 4.5 (2–9) h. 327 patients (34%) were placed in prone position on the operation table, 258 patients (26%) in supine position, and 393 patients (40%) in lateral position. All operative procedures were performed under general anesthesia.

Intraoperative complications were seen in 21 patients (2%), and postoperative complications in 171 (18%) (Table 3). 543 patients required intensive care. The average time in ICU was 14 days. The average duration of postoperative recumbency was 19 (6–57) days. Average duration of hospital stay was 37 (11–163) days. 36 patients (4%) died following spinal surgery. 6 of them died during operation and 30 of them during postoperative recumbency due to causes other than thromboembolic disease.

111 patients (11%) suffered from adipositas and 627 (64%) reported regular smoking. Standard laboratory screening of 9 patients (1%) showed relevant bleeding disorders before surgery, with a significantly prolonged prothrombin time in 6 cases and a low platelet count in 3 cases.

The overall incidence of neurological deficits preoperatively was 53%. 30 patients showed motor deficits in the lower extremities, 45 patients sensory deficits, and 225 patients both motor and sensory deficits. 222 patients (23%) showed a complete hemi- or tetraplegia. Complete recovery from neurological deficits was seen in 441 patients (84%) after surgery, while the neurological deficits resolved incompletely in 81 patients (16%).

792 patients (81%) received medical antithrombotic prophylaxis postoperatively, following the routine practice of the department. The patients received low-molecular-weight heparin at a dose of 1.0–1.5 mg per kg of body weight. 153 patients (16%) also had graduated compression stockings as a further prophylactic measure. 21 patients only had compression stockings as mechanical prophylaxis. 12 patients had no prophylaxis at all. 6 of them had severe bleeding complications after surgery and the other six died during operation.

22 patients (2.2%) developed symptomatic thromboembolic complications after spinal surgery: 4 female and 18 male patients with an average age of 52 (34–79) years showed clinical signs

Table 3. Intra- and postoperative complications

Complication	n
Cardiorespiratory problems	39
Hemorrhagic complications	38
Infections	36
Pneumonia	31
Metabolic disorders	25
Implant failures	18
Other complications	5

of deep venous thrombosis and/or pulmonary embolism with a mean postoperative follow-up period of 17 (\pm 4) days after surgical procedures. 17 patients showed clinical signs of deep venous thrombosis; 4 of them subsequently developed pulmonary embolism. 5 patients developed pulmonary embolism without prior clinical signs of deep venous thrombosis. In all 22 patients, symptomatic thromboembolism was diagnosed by clinical suspicion followed by extensive examinations.

The 22 patients with symptomatic thromboembolic disease underwent spinal surgery due to fractures in 12 cases, due to fractures with dislocation in 8 cases, and to discoligamentary instabilities of the spine in 2 cases. 2 patients underwent surgical procedures at the cervical spine, 5 patients at the thoracic spine, 14 patients at the lumbar spine and 1 patient at more than one level. 16 patients underwent only one operative procedure, whereas 6 patients had two operations. Anterior spinal fusion was performed in 15 patients; 2 patients had both anterior and posterior spinal fusion. 4 patients underwent decompression and posterior fusion at one procedure followed by video-assisted thoracoscopic spinal fusion at second surgery. 1 patient underwent video-assisted thoracoscopic spinal fusion only (5%). The average length of operative procedures was 2.5 (2–3.5) h. 10 patients were placed in supine position, and 6 patients in lateral position.

Intra- or postoperative complications were seen in 3 patients after spinal surgery: 2 patients were suffering from pneumonia and required extensive intensive care treatment. The third patient developed a mild wound infection. Reoperation was not necessary in any of the patients. Finally, there were 6 cases of death following pulmonary embolism.

Table 4. Odds ratio estimates

Effect	Point estimate	95% Wald confidence limits
Age	0.946	0.915–0.979
Gender	2.088	0.266–1.887
Tobacco use	0.177	0.038–0.818
Obesity	0.175	0.052–0.588
Bleeding disorders	0.054	0.004–0.801
Cervical spine level	16.014	1.067–240.298
Thoracic spine level	5.086	0.408–63.343
Lumbar spine level	1.919	0.177–20.845
Anterior approach	0.963	0.080–11.621
Posterior approach	4.257	0.329–55.091
Number of operations	3.597	1.256–10.298
Operative time	1.018	1.010–1.027
Neurological deficits	0.162	0.046–0.574
Immobilization	0.334	0.890–4.621
Prophylaxis	1.889	0.977–1.883

Concerning previously noted general risk factors for thromboembolic complications, 19 of 22 patients declared regular smoking, 7 patients suffered from adipositas, and 2 patients had a relevant bleeding disorder. All 22 patients had undergone systemic antithrombotic prophylaxis with low-molecular-weight heparin after surgery. None of them had any further prophylactic measures. Thromboembolic complications were seen more frequently in older patients and in males, and also in patients who reported regular smoking or who suffered from obesity. Regression analysis also showed that thromboembolic complications were seen more frequently in patients with surgical procedures at the lumbar spine and in patients who underwent anterior spinal approach. Thromboembolic disease was also found significantly more often in patients with motor deficits in the lower extremities. An overview of risk estimates following logistic regression stepwise procedure is given in Table 4.

Discussion

Historically, symptomatic thromboembolic disease has been considered a rare occurrence, but the exact incidence of clinically evident deep venous thrombosis and pulmonary embolism spanning over a longer period of time has not been deter-

mined (West and Anderson 1992, Oda et al. 2000). Previous studies have reported incidence rates of between 0.5% and 2.5%, but these have been restricted to small patient series (Lea et al. 1978, Rokito et al. 1996, Dearborn et al. 1999, Oda et al. 2000). We found a rate of 2.2% (n 22) over the 25-year period, which is similar to results reported in the literature (Lea et al. 1978, Dearborn et al. 1999, Brambilla et al. 2004). When we planned this retrospective study, we assumed that there would be a significantly higher rate of clinically evident thromboembolic complications, as we had had 2 cases of fatal pulmonary embolism in a time period of 4 months.

It is widely accepted that general risk factors such as age, sex, obesity and tobacco consumption increase the risk of developing thromboembolic complications (Ferree and Wright 1993, Ferree et al. 1993, Smith et al. 1994, Rokito et al. 1996, Lee et al. 2000, Oda et al. 2000, Andersson and Spencer 2003, Brambilla et al. 2004). We found that deep venous thrombosis and pulmonary embolism were more common in older patients, and in males, and also in patients with obesity and regular smoking. Various specific risk factors have also been reported to play an important role in predicting enhanced risk of DVT or PE after spinal surgery (Ferree and Wright 1993, Rokito et al. 1996, Dearborn et al. 1999, Lee et al. 2000, Oda et al. 2000, Brambilla et al. 2004). Factors such as level, type and length of operative procedure, duration of postoperative immobilization, motor neurological deficits in the lower extremities, or surgical approach might influence the risk of thromboembolism. A number of authors have reported an increased incidence of thromboembolic complications in patients undergoing spinal surgery at the thoracic or lumbar spine, in patients subject to an anterior spinal approach, and in patients placed in prone position on the operating table (Ferree et al. 1993, Smith et al. 1994, Rokito et al. 1996, Dearborn et al. 1999). We have found that the level of injury, the surgical setting and the surgical procedure can be associated with a higher risk of developing postoperative thromboembolism. In our series, DVT or PE was seen more frequently in patients with injuries at the lumbar spine, as well as in patients who had been operated with an anterior spinal approach. The combination of these two factors in particu-

lar, injury of the lumbar spine requiring anterior surgical approach, may substantially increase the risk of developing thromboembolic complications postoperatively. Apart from level of injury and type of surgical approach, a high-impact mechanism of injury and neurological deficits in the lower extremities may also be relevant risk factors in thromboembolic disease. We found that neurological deficits in the lower extremities were more frequent in patients with clinical signs of DVT or PE than in patients without thromboembolic complications.

Although clinically evident thromboembolic complications have been reported to be low in patients with major spinal surgery, primary prevention using pharmacological and mechanical methods has gained wide acceptance in clinical practice (Kearon 2003, O'Donnell and Weitz 2003, Brambilla et al. 2004, Weitz 2004). In our series, all patients had undergone medical antithrombotic prophylaxis postoperatively, following the routine practice at the department. Several authors have argued that the disadvantages of systemic anticoagulation therapy might outweigh any possible benefit because bleeding complications can be expected in up to 4% of patients receiving medical antithrombotic prophylaxis (Hull et al. 1982, McLaren and Bailey 1986, Cain et al. 1995, Rokito et al. 1996). We experienced bleeding complications in 3% of the patients (n 27), but only 6 of them showed sufficiently severe bleeding complications that systemic prophylaxis had to be discontinued.

We usually use systemic anticoagulation therapy in patients with spinal surgery, and we add mechanical prophylaxis in patients with spinal surgery and general or specific risk factors. However, no conclusions about the value of systemic or mechanical prevention can be drawn from this study. The retrospective design can be criticized, but our study contains a large number of patients over a time period of more than 2 decades.

Contributions of authors

PP preparation of the study, review of admission data and the trauma registry, examination of patient data, and writing of the manuscript. GT preparation of the manuscript; listing of literature. MJ review of admission data and the trauma registry and examination of the data. AO review of admission

data and the trauma registry and examination of the data. TB statistical analysis. VV preparation of the study, institutional review. CG senior author, preparation of the study, institutional review.

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- Anderson F A, Spencer F A. Risk factors for venous thromboembolism. *Circulation* 2003; 107: 19-116.
- Anderson F A, Hirsh J, White K, Fitzgerald R H Jr, Hip and Knee Registry Investigators. Temporal trends in prevention of venous thromboembolism following total hip or knee arthroplasty 1996-2001: findings from the hip and knee registry. *Chest* 2003; 124:349-56.
- Bailey S I, McLaren A C. Cauda equina syndrome following lumbar discectomy. *J Bone Joint Surg (Br)* 1984 ; 66: 298-9.
- Brambilla S, Ruosi C, La Maida G A, Caserta S. Prevention of venous thromboembolism in spinal surgery. *Eur Spine J* 2004; 13: 1-8.
- Cain J E, Major M R, Lauerma W C, West J L, Wood K B, Fueredi G A. The morbidity of heparin therapy after development of pulmonary embolus in patients undergoing thoracolumbar or lumbar spinal fusion. *Spine* 1995; 20: 1600-3.
- Dearborn J T, Hu S S, Tribus C D, Bradford D S. Thromboembolic complications after major thoracolumbar spine surgery. *Spine* 1999; 24: 1471-6.
- Ferree B A, Wright A M. Deep venous thrombosis following posterior lumbar spinal surgery. *Spine* 1993; 18: 1079-82.
- Ferree B A, Stern P J, Jolson R S, Roberts J M, Kahn A. Deep venous thrombosis after spinal surgery. *Spine* 1993; 18: 315-9.
- Hull R, Hirsh J, Jay R, Carter C, England C, Gent M, Turpie A G, McLoughlin D, Dodd P, Thomas M, Raskob G, Ockelford P. Different intensities of oral anticoagulant therapy in treatment of proximal-vein thrombosis. *N Eng J Med* 1982; 307: 1676-81.
- Kearon C. Duration of venous thromboembolism prophylaxis after surgery. *Chest* 2003; 124: 386-92.
- Lea T M, MacDonald L M. Complications of ascending phlebography of the leg. *BMJ* 1978; 2: 317-8.
- Lee H M, Suk K S, Moon S H, Kim D J, Wang J M, Kim N H. Deep vein thrombosis after major spinal surgery. *Spine* 2000; 25: 1827-30.
- McLaren A C, Bailey S I. Cauda equina syndrome: a complication of lumbar discectomy. *Clin Orthop* 1986; (204): 143-9.
- Oda T, Fuji T, Kato Y, Fujita S, Kanemitsu N. Deep venous thrombosis after posterior spinal surgery. *Spine* 2000; 25: 2962-7.
- O'Donnell M, Weitz J I. Thromboprophylaxis in surgical patients. *Can J Surg* 2003; 46: 129-35.
- Rokito E R, Schwartz M C, Neuwirth M G. Deep vein thrombosis after major reconstructive spinal surgery. *Spine* 1996; 21: 853-9.

Smith M D, Bressler E L, Lonstein J E, Winter R, Pinto M R, Denis F. Deep venous thrombosis and pulmonary embolism after major reconstructive operations on the spine. *J Bone Joint Surg (Am)* 1994; 76: 980-5.

Weitz J I. New anticoagulants for treatment of venous thromboembolism. *Circulation (Suppl 1)* 2004; 110: 119-126.

West J L, Anderson L D. Incidence of deep vein thrombosis in major adult spinal surgery. *Spine* 1992; 17: 254-7.